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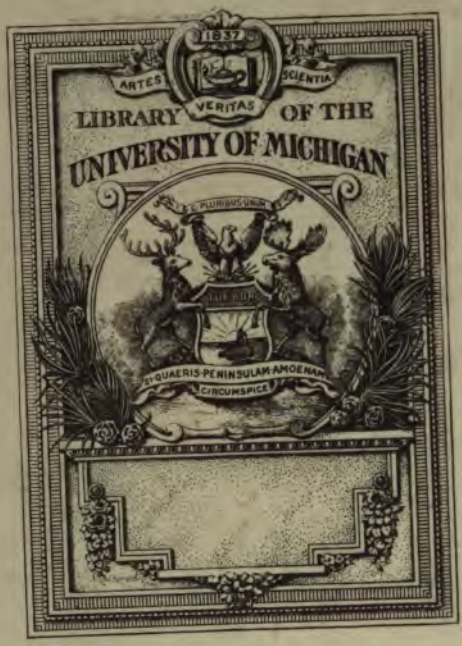

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PRESIDENTS OF THE SOCIETY FROM ITS FORMATION AS THE "MEDICO-CHIRURGICAL SOCIETY," 1805

ELECTED	
1805	WILLIAM SAUNDERS, M.D.
1808	MATTHEW BAILLIE, M.D.
1810	SIR HENRY HALFORD, Bart., M.D., G.C.H.
1813	SIR GILBERT BLANE, Bart., M.D.
1815	HENRY CLINE
1817	WILLIAM BABINGTON, M.D.
1819	SIR ASTLEY PASTON COOPER, Bart., K.C.H.
1821	JOHN COOKE, M.D.
1823	JOHN ABERNETHY
1825	GEORGE BIRKBECK, M.D
1827	BENJAMIN TRAVERS
1829	PETER MARK ROGET, M.D.
1831	SIR WILLIAM LAWRENCE, Bart.
1833	JOHN ELLIOTSON, M.D. (First President of the Society after its Incorporation as the Royal Medical and Chirurgical Society of London in 1834).
1835	HENRY EARLE
1837	RICHARD BRIGHT, M.D.
1839	SIR BENJAMIN COLLINS BRODIE, Bart.
1841	ROBERT WILLIAMS, M.D.
1843	EDWARD STANLEY
1845	WILLIAM FREDERICK CHAMBERS, M.D, K.C.H.
1847	JAMES MONCRIEFF ARNOTT
1849	THOMAS ADDISON, M.D.
1851	JOSEPH HODGSON
1853	JAMES COPLAND, M.D.
1855	CÆSAR HENRY HAWKINS
1857	SIR CHARLES LOCOCK, Bart., M.D.
1859	FREDERIC CARPENTER SKEY
1861	BENJAMIN GUY BABINGTON, M.D.
1863	RICHARD PARTRIDGE
1865	SIR JAMES ALDERSON, M.D.
1867	SAMUEL SOLLY
1869	SIR GEORGE BURROWS, Bart., M.D.
1871	THOMAS BLIZARD CURLING
1873	CHARLES JAMES BLASIUS WILLIAMS, M.D.
1875	SIR JAMES PAGET, Bart.
1877	CHARLES WEST, M.D.
1879	JOHN ERIC ERICHSEN
1881	ANDREW WHYTE BARCLAY, M.D
1882	JOHN MARSHALL
1884	SIR GEORGE JOHNSON, M.D.
1886	GEORGE DAVID POLLOCK
1888	SIR EDWARD HENRY SIEVEKING, M.D.
1890	TIMOTHY HOLMES
1892	SIR ANDREW CLARK, Bart., M.D. (*Died 6th Nov.*, 1893, *and Sir. W. S. Church, Senior* [*Medical*] *Vice-President, acted as President until 1st March*, 1894.)
1894	JONATHAN HUTCHINSON
1896	WILLIAM HOWSHIP DICKINSON, M.D.
1898	THOMAS BRYANT
1900	FREDERICK WILLIAM PAVY, M.D., LL.D., F.R.S.
1902	ALFRED WILLETT
1904	SIR RICHARD DOUGLAS POWELL, Bart., K.C.V.O., M.D.

HONORARY FELLOWS

(Limited to Twelve.)

Elected

1887 FOSTER, SIR MICHAEL, K.C.B., M.D., LL.D., F.R.S., M.P., Professor of Physiology in the University of Cambridge, Nine Wells, Great Shelford, Cambridge.

1868 HOOKER, SIR JOSEPH DALTON, M.D., C.B., G.C.S.I., D.C.L., LL.D., F.R.S., Corresponding Member of the Academy of Sciences of France; The Camp, Sunningdale.

1896 KELVIN, The Right Hon. LORD, P.C., G.C.V.O., F.R.S., Pres. R.S.E., D.C.L., LL.D., &c., Glasgow.

1878 AVEBURY, The Right Hon. LORD, D.C.L., LL.D., F.R.S., High Elms, Farnborough, Kent, R.S.O.

1887 TURNER, SIR WILLIAM, M.B., D.C.L., LL.D., F.R.S., Principal of the University of Edinburgh; 6, Eton Terrace, Edinburgh.

FOREIGN HONORARY FELLOWS

(Limited to Twenty.)

Elected

1878 Baccelli, Guido, M.D., Rome.

1896 von Bergmann, Ernst, Berlin.

1887 Billings, John S., M.D., D.C.L.Oxon., New York.

1896 Czerny, Vincent, M.D., Heidelberg.

1896 Erb, Wilhelm, M.D., Professor of Clinical Medicine, Heidelberg.

1887 von Esmarch, His Excellency Friedrich, M.D., Kiel.

1896 Fournier, Alfred, M.D., Paris.

1896 Koch, Robert, M.D., Berlin.

1896 Kocher, Theodore, M.D., Berne.

1868 Kölliker, Albert, Würzburg.

1896 Laveran, A., M.D., Paris.

1896 Marie, Pierre, M.D., Paris.

1896 Mitchell, Samuel Weir, M.D., Philadelphia.

FELLOWS

OF THE

ROYAL MEDICAL AND CHIRURGICAL SOCIETY

OF LONDON

EXPLANATION OF THE ABBREVIATIONS

P.—President,	C.—Member of Council.
V.P.—Vice-President.	*Sci. Com.*—Member of a Scientific Committee
T.—Treasurer.	*Ho. Com.*—Member of House Committee.
L.—Hon. Librarian.	*Lib. Com.*—Member of Library Committee.
S.—Hon. Secretary.	*Bldg. Com.*—Member of Building Committee.
	Dis. Com.—Member of Discussions Committee.

Trans. and *Pro.*, followed by figures, show the number of Papers which have been contributed to the *Transactions* or *Proceedings* by the Fellow whose name they follow. *Referee, Sci. Com., Lib. Com., Bldg. Com., Ho. Com.*, and *Dis. Com.*, with the dates of office, are attached to the names of those who have served as Referees of papers and on the Committees of the Society.

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Names printed in this *type* are of those Fellows who have paid the Composition Fee entitling them to receive the *Transactions*.

[N.B.—Fellows are reminded that they are, themselves, responsible for the correctness of the descriptions in the following lists, and it is particularly requested that any change of Title, Appointment, or Residence may be communicated to the Secretary before the 1st of July in each year.]

Resident Fellows	xii
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RESIDENT FELLOWS

Elected

1898 AARONS, S. JERVOIS, M.D., 14, Stratford place, Oxford street.

1877 **Abercrombie,** JOHN, M.D., Physician to, and Lecturer on Forensic Medicine at, Charing Cross Hospital; 23 Upper Wimpole street, Cavendish square. C. 1896 *Referee*, 1898—. *Trans.* 2.

1885 ABRAHAM, PHINEAS S., M.A., M.D., Dermatologist to the West London Hospital, Assistant Surgeon to Hospital for Diseases of the Skin, Blackfriars; 2, Henrietta street, Cavendish square.

1885 ACLAND, THEODORE DYKE, M.D., Physician to St. Thomas's Hospital, and Physician to the Hospital for Consumption and Diseases of the Chest, Brompton; 19, Bryanston square.

1897 ADDISON, CHRISTOPHER, M.D., Charing Cross Hospital Medical School, Chandos street.

1879 ALLCHIN, WILLIAM HENRY, M.D., F.R.S. Ed., Senior Physician to the Westminster Hospital; 5, Chandos street, Cavendish square. C. 1898-9. *Referee*, 1897.

1890 ALLINGHAM, HERBERT WILLIAM, Surgeon to His Majesty's Household; Surgeon in Ordinary to H.R.H. the Prince of Wales; Assistant Surgeon to St. George's Hospital; 25, Grosvenor street, Grosvenor square.

1888 ANDERSON, JOHN, M.D., C.I.E., Physician to the Seamen's Hospital, Greenwich; Lecturer on Tropical Medicine at St. Mary's Hospital Medical School; 9, Harley street, Cavendish square.

1891 ANDREWES, FREDERICK WILLIAM, M.D., Highwood, Hampstead lane, Highgate.

1902 ARMOUR, DONALD JOHN, M.B., Assistant Surgeon to the West London Hospital; Senior Assistant Surgeon to the Belgrave Hospital for Children; 89, Harley street.

1903 ASCHERSON, WILLIAM LAWRENCE, M.B., B.C., 37, Brunswick gardens, Campden hill.

1893 BAILEY, ROBERT COZENS, M.S., 21, Welbeck street, Cavendish square.

Elected

1891 BAKER, CHARLES ERNEST, M.B., 5, Gledhow gardens, South Kensington.

1900 BALDWIN, ASLETT, 6, Manchester square.

1887 BALL, JAMES BARRY, M.D., Physician to the West London Hospital; 12, Upper Wimpole street, Cavendish square.

1885 BALLANCE, CHARLES ALFRED, M.S., Assistant Surgeon to St. Thomas's Hospital and to the Hospital for Sick Children, Great Ormond street; Surgeon to the National Hospital for the Paralysed and Epileptic, Queen square; 106, Harley street, Cavendish square. *Referee*, 1904—. *Trans.* 6.

1879 BARKER, ARTHUR EDWARD JAMES, Professor of the Principles and Practice of Surgery and Professor of Clinical Surgery at University College, and Surgeon to University College Hospital, London; 87, Harley street, Cavendish square. C. 1895-7. *Referee*, 1897—. *Trans.* 7.

1876 **Barlow**, SIR THOMAS, Bart., K.C.V.O., M.D., B.S., *Trustee for Debenture-holders;* Physician to His Majesty's Household; Physician to University College Hospital; 10, Wimpole street, Cavendish square. C. 1892. S. 1899-1902. *Referee*, 1896-9. *Trans.* 2.

1902 BARNARD, HAROLD L., M.S., 21, Wimpole street.

1893 BARRETT, HOWARD, 49, Gordon square.

1880 BARROW, A. BOYCE, Surgeon to King's College Hospital; 8, Upper Wimpole street, Cavendish square. C. 1903—4.

1896 BARTON, JAMES KINGSTON, 14, Ashburn place, Courtfield road, South Kensington.

1903 BARWELL, HAROLD SHUTTLEWORTH, M.B., 55, Wimpole street.

1859 BARWELL, RICHARD, Consulting Surgeon to the Charing Cross Hospital; 55, Wimpole street. C. 1876-77. V.P. 1883-4. *Referee*, 1868-75, 1879-82. *Trans.* 12. *Pro.* 1.

Elected

1868 **Bastian, Henry Charlton, M.A., M.D., F.R.S., Emeritus Professor of the Principles and Practice of Medicine and of Clinical Medicine in University College, London; Consulting Physician to University College Hospital and Physician to the National Hospital for the Paralysed and Epileptic; 8a, Manchester square. C. 1885. V.P. 1904—. *Referee*, 1886-96. *Trans.* 3.**

1890 **Bateman, William A. F., Bridge House, Richmond, Surrey.**

1891 **Batten, Frederick E., M.D., B.C., 33, Harley street.**

1875 **Beach, Fletcher, M.B., Physician to the West End Hospital for Nervous Diseases, Winchester House, Kingston Hill [79, Wimpole street].**

1883 **Beale, Edwin Clifford, M.A., M.B., Physician to the City of London Hospital for Diseases of the Chest, and Physician to the Great Northern Central Hospital; 23, Upper Berkeley street.**

1862 **Beale, Lionel Smith, M.B., F.R.S., late Professor of the Principles and Practice of Medicine in King's College, London, and Consulting Physician to King's College Hospital; 6, Bentinck street, Manchester square. C. 1876-7. *Referee*, 1873-5. *Trans.* 1.**

1897 **Beddard, A. P., M.D., Assistant Physician to Guy's Hospital; 44, Seymour street.**

1880 **Beevor, Charles Edward, M.D., Physician for Out-patients to the National Hospital for the Paralysed and Epileptic, and to the Great Northern Hospital; 135, Harley street, Cavendish square. C. 1900-2. *Referee*, 1896-1900. *Trans.* 1.**

1901 **Beevor, Sir Hugh Reeve, Bart., M.D., 17, Wimpole street, Cavendish square.**

1877 **Bennett, Sir William Henry, K.C.V.O., Surgeon to St. George's Hospital; 1, Chesterfield treet, Mayfair. C. 1893-4. *Referee*, 1892-93, 1899—. *Trans.* 4.**

1897 **Berkeley, Comyns, M.B., B.C., Physician to Out-Patients, Chelsea Hospital for Women; 53, Wimpole street.**

Elected

1885 BERRY, JAMES, B.S., Surgeon to the Royal Free Hospital, and Lecturer on Surgery at the London School of Medicine for Women; Demonstrator of Practical Surgery, St. Bartholomew's Hospital; 21, Wimpole street, Cavendish square.

1893 BIDWELL, LEONARD A., Senior Assistant Surgeon to the West London Hospital; 15, Upper Wimpole street Cavendish square.

1897 BLACKER, G. F., M.D., Obstetric Physician to Universit College Hospital and to the Great Northern Central Hospital; 11, Wimpole street, Cavendish square.

1901 BLAIKIE, J. BRUNTON, M.D., C.M., 70, Brook street, Grosvenor square.

1883 BLAND-SUTTON, JOHN, Assistant Surgeon to the Middlesex Hospital; Surgeon to the Chelsea Hospital for Women; 47, Brook street, Grosvenor square. *Trans.* 6.

1865 **Blandford,** GEORGE FIELDING, M.D., Lecturer on Psychological Medicine at St. George's Hospital; 48, Wimpole street, Cavendish square. C. 1883-4. V.P. 1898-1900.

1902 BLUMFELD, JOSEPH, M.D., B.C., 7, Cavendish place, Cavendish square.

1891 BOKENHAM, THOMAS JESSOPP, 10, Devonshire street, Portland place.

1903 BOLTON, CHARLES, M.D., 22, Bentinck street, Manchester square.

1882 **Bowlby,** ANTHONY ALFRED, C.M.G., Surgeon to St. Bartholomew's Hospital; 24, Manchester square. C. 1903—4. *Trans.* 8.

1870 *Bowles,* ROBERT LEAMON, M.D., Consulting Physician to the Folkestone Hospital and Physician to St. Andrew's Home, Folkestone; 16, Upper Brook street, Grosvenor square. C. 1897-9. *Sci. Com.* 1896-1902. *Trans.* 3.

Elected

1886 BOXALL, ROBERT, M.D., Obstetric Physician to Out-patients, and Lecturer on Midwifery and Diseases of Women, at the Middlesex Hospital; 40, Portland place.

1884 BOYD, STANLEY, B.S., Surgeon to, and Lecturer on Surgery at, the Charing Cross Hospital; Surgeon to the Paddington Green Children's Hospital; Consulting Surgeon to the New Hospital for Women; 134, Harley street, Cavendish square. C. 1904—. *Referee*, 1895—1904. *Trans.* 1.

1890 BRADFORD, JOHN ROSE, M.D., D.Sc., F.R.S., Physician to University College Hospital; 8, Manchester square. *Referee*, 1899—. *Trans.* 1.

1897 BRAILEY, WILLIAM ARTHUR, M.D., 11, Old Burlington street.

1904 BRANSON, WILLIAM PHILIP SUTCLIFFE, M.B., St. Bartholomew's Hospital.

1901 BREWERTON, ELMORE WRIGHT, 45, Weymouth street, Portland place.

1898 **Broadbent**, J. F. H., M.D., 35, Seymour street.

1868 **Broadbent**, SIR WILLIAM HENRY, Bart., K.C.V.O., M.D., F.R.S., LL.D., Physician in Ordinary to H.M. the King; Consulting Physician to St. Mary's Hospital; Consulting Physician to the London Fever Hospital; 84, Brook street, Grosvenor square. C. 1885. *Referee*, 1881-4, 1891-7. *Trans.* 5.

1880 BROWNE, JAMES WILLIAM, M.B., 37, Holland Park avenue. C. 1900-1.

1881 BROWNE, OSWALD AUCHINLECK, M.A., M.D., Physician to the Royal Hospital for Diseases of the Chest and to the Metropolitan Hospital; 7, Upper Wimpole street.

1874 BRUCE, JOHN MITCHELL, M.D., Physician to, and Lecturer on Medicine at, the Charing Cross Hospital; Consulting Physician to the Hospital for Consumption, Brompton; 23, Harley street. C. 1892, 1897-9. S. 1893-6. *Sci. Com.* 1889-1902. *Ho. Com.* 1898-9. *Referee*, 1886-91. *Lib. Com.* 1888-91. *Trans.* 3.

Elected

1898 BRUCE, SAMUEL NOBLE, 15, Queensborough terrace, Hyde Park.

1871 BRUNTON, SIR THOMAS LAUDER, M.D., D.Sc. LL.D., F.R.S., Consulting Physician to, and late Lecturer on Pharmacology and Therapeutics at, St. Bartholomew's Hospital; 10, Stratford place, Oxford street. C. 1888-9. *Referee*, 1880-87. *Lib. Com.* 1882-7. *Trans.* 2.

1898 BRYANT, J. H., M.D., Assistant Physician to Guy's Hospital; 4, St. Thomas's street, London bridge.

1860 **Bryant**, THOMAS, M.Ch., Honorary Surgeon-in-Ordinary to H.M. the King, Consulting Surgeon to Guy's Hospital; Member of the Société de Chirurgie, Paris; 27, Grosvenor street, Grosvenor square. P. 1898-1900. C. 1873-4. V.P. 1885-6. *Sci. Com.* 1863. *Referee*, 1882-4. *Lib. Com.* 1868-71. *Trans.* 17. *Pro.* 1.

1901 BUCKNALL, THOMAS RUPERT HAMPDEN, M.S., M.D.; 35, Harley street, Cavendish square.

1893 BURGHARD, FRÉDÉRIC FRANÇOIS, M.D., M.S., Surgeon to King's College Hospital and Paddington Green Children's Hospital; 86, Harley street, Cavendish square.

1903 BURROWS, HAROLD, M.B., B.S., Caragh, Lyford road, Wandsworth common.

1885 BUTLER-SMYTHE, ALBERT CHARLES, Senior Out-Patient Surgeon, Samaritan Free Hospital for Women and Children, Soho; Senior Surgeon to the Grosvenor Hospital for Women and Children; 76, Brook street, Grosvenor square.

1873 **Butlin**, HENRY TRENTHAM, D.C.L., Surgeon to St. Bartholomew's Hospital; 82, Harley street, Cavendish square. C. 1887-8. V.P. 1904—. *Referee*, 1893—1904. *Trans.* 4. *Pro.* 1.

Elected

1896 BUTTAR, CHARLES, M.D., 10, Kensington gardens square, Bayswater. *Pro.* 1.

1883 BUXTON, DUDLEY WILMOT, M.D., B.S., Administrator, and Teacher of the Use, of Anæsthetics, in University College Hospital; Consulting Anæsthetist to the National Hospital for the Paralysed and Epileptic, Queen square, and Anæsthetist to the London Dental Hospital; 82, Mortimer street, Cavendish square.

1899 BUZZARD, EDWARD FARQUHAR, M.D., 33, Harley street Cavendish square.

1868 **Buzzard,** THOMAS, M.D., Physician to the National Hospital for the Paralysed and Epileptic; 74, Grosvenor street, Grosvenor square. C. 1885-6. *Referee,* 1887—.

1885 CAHILL, JOHN, M.D., 12, Seville street, Lowndes square.

1893 CALEY, HENRY ALBERT, M.D., Physician in charge of Out-patients, Lecturer on Materia Medica and Therapeutics, and Dean of the Medical School, St. Mary's Hospital; 24, Upper Berkeley street, Portman square.

1887 CALVERT, JAMES, M.D., 113, Harley street. *Trans.* 1.

1897 CANTLIE, JAMES, M.B., 46, Devonshire street.

1901 CARGILL, LIONEL VERNON, Assistant Ophthalmic Surgeon to King's College Hospital; Ophthalmic Surgeon to the Seamen's Hospital Society; Surgeon to the Royal Eye Hospital, Southwark; 31, Harley street, Cavendish square.

1888 CARLESS, ALBERT, M.S., Professor of Surgery in King's College, London; Surgeon to King's College Hospital; 10, Welbeck street.

1896 CARR, J. WALTER, M.D., Physician to the Royal Free Hospital; Physician to the Victoria Hospital for Children; 19, Cavendish place. *Trans.* 1.

1903 CARRUTHERS, SAMUEL WILLIAM, M.D., C.M., 44, Central hill, Norwood.

Elected

1888 CAUTLEY, EDMUND, M.D., B.C., 15, Upper Brook street. *Trans.* 2.

1871 **Cayley**, WILLIAM, M.D., Consulting Physician to the Middlesex Hospital, Consulting Physician to the London Fever Hospital, and to the North-Eastern Hospital for Children; 120, Queen's road, Richmond. C. 1888. *Referee*, 1886-7, 1899-1903. *Lib. Com.* 1886-7. *Trans.* 2.

1879 CHAMPNEYS, FRANCIS HENRY, M.D., Physician-Accoucheur and Lecturer on Obstetric Medicine at St. Bartholomew's Hospital; 42, Upper Brook street, Grosvenor square. C. 1898-1900. *Referee*, 1891-8. *Lib. Com.* 1885-98. *Trans.* 8.

1868 **Cheadle**, WALTER BUTLER, M.D., Physician to, and Lecturer on Clinical Medicine at, St. Mary's Hospital; Consulting Physician to the Hospital for Sick Children; 19, Portman street, Portman square. *Trustee* 1888-1903. *Marshall Hall Trustee* 1873-1903. S. 1886-8. C. 1890-91. V.P. 1904—. *Sci. Com.* 1889-95. *Bldg. Com.* 1889-92. *Referee*, 1885. *Trans.* 1.

1879 CHEYNE, WILLIAM WATSON, C.B., M.B., F.R.S., Surgeon to King's College Hospital, and Professor of Clinical Surgery in King's College, London; 75, Harley street, Cavendish square. C. 1897-9. *Referee*, 1894-7, 1904—. *Lib. Com.* 1886-8, 1891-6. *Trans.* 1.

1890 CHILDS, CHRISTOPHER, M.D., D.P.H., Knight of Grace of St. John, 10, Manchester square.

1866 **Church**, SIR WILLIAM SELBY, Bart., K.C.B., M.D., *Hon. Treasurer*, President of the Royal College of Physicians of London, Physician to, and Lecturer on Clinical Medicine at, St. Bartholomew's Hospital; 130, Harley street, Cavendish square. C. 1885-6. V.P. 1892-4. T. 1894—. *Referee*, 1874-81. *Ho. Com.* 1898—.

1879 CLARK, ANDREW, Surgeon to, and Lecturer on Surgery at, the Middlesex Hospital; 71, Harley street, Cavendish square.

Elected

1882 CLARKE, ERNEST, M.D., B.S., Surgeon to the Central London Ophthalmic Hospital; Ophthalmic Surgeon to the Miller Hospital; 3, Chandos street, Cavendish square.

1890 CLARKE, JAMES JACKSON, M.B., Assistant Surgeon to the North-West London and City Orthopædic Hospitals; 18, Portland Place.

1848 **Clarke**, JOHN, M.D., 48, Carlisle place, Victoria street. C. 1866.

1888 CLARKE, ROBERT HENRY, M.B., 80, Hamlet Gardens, Ravenscourt Park.

1881 CLARKE, W. BRUCE, M.B., Assistant Surgeon to, and Lecturer on Anatomy at, St. Bartholomew's Hospital; Surgeon to the West London Hospital; 51, Harley street, Cavendish square. C. 1899-1901. *Trans.* 1.

1879 **Clutton**, HENRY HUGH, M.B., M.C., Surgeon to St. Thomas's Hospital; 2, Portland place. C. 1897-9. *Dis. Com.* 1897-8. *Referee*, 1896-7. *Trans.* 3.

1888 COCK, FREDERICK WILLIAM, M.D., 1, Porchester Houses. Porchester square.

1902 COLLIER, JAMES STANSFIELD, M.D., B.Sc., 57A, Wimpole street.

1897 COLMAN, W. S., M.D., Assistant Physician to St. Thomas's Hospital; 9, Wimpole street.

1865 COOPER, SIR ALFRED, Surgeon in Ordinary to H.R.H. the Duke of Saxe-Coburg-Gotha; Consulting Surgeon to the West London Hospital and to St. Mark's Hospital; 9, Henrietta street, Cavendish square.

1902 COTTON, HOLLAND JOHN, M.D., C.M., 33, Lowndes street.

1860 **Couper**, JOHN, Consulting Surgeon to the Royal London Ophthalmic Hospital and to the London Hospital; 80, Grosvenor street. C. 1876. *Referee*, 1882-3.

Elected

1877 COUPLAND, SIDNEY, M.D., Commissioner in Lunacy; late Physician to, and Lecturer on Medicine at, the Middlesex Hospital; 16, Queen Anne street, Cavendish square. C. 1893-4. *Referee*, 1892-3. *Ho. Com.* 1895-8.

1862 **Cowell,** GEORGE, Consulting Surgeon to the Westminster Hospital and to the Royal Westminster Ophthalmic Hospital; 24, Harrington gardens, South Kensington. C. 1882-3.

1897 CRAWFURD, RAYMOND H. PAYNE, M.D., 71, Harley street.

1878 CRICHTON-BROWNE, SIR JAMES, M.D., LL.D., F.R.S., Lord Chancellor's Visitor in Lunacy; 61, Carlisle place Mansions, Victoria street.

1874 CRIPPS, WILLIAM HARRISON, Surgeon to St. Bartholomew's Hospital; 2, Stratford place, Oxford street. C. 1890-91. *Trans.* 1.

1882 CROCKER, HENRY RADCLIFFE, M.D., Physician to the Skin Department, University College Hospital; 121, Harley street, Cavendish square. C. 1903-4. *Trans.* 3.

1898 CROMBIE, ALEXANDER, C.B., M.D., 3, Bickenhall Mansions, Gloucester place.

1890 CROWLE, THOMAS HENRY RICKARD, 35, St. James's place.

1888 CULLINGWORTH, CHARLES JAMES, M.D., D.C.L., Obstetric Physician and Lecturer on Diseases of Women to St. Thomas's Hospital; 14, Manchester square. *Referee*, 1896—.

1879 CUMBERBATCH, A. ELKIN, M.B., Aural Surgeon to St. Bartholomew's Hospital, and to the National Hospital for the Paralysed and Epileptic; 11, Park crescent, Portland place. *Trans.* 1.

1898 CURRIE, A. STARK, M.D., 81, Queen's road, Brownswood park.

Elected

1886 DAKIN, WILLIAM RADFORD, M.D., Obstetric Physician to, and Lecturer in Midwifery at, St. George's Hospital, and Physician to the General Lying-in Hospital; 8, Grosvenor street, Grosvenor square. C. 1904—. *Lib. Com.* 1902—.

1872 DALBY, SIR WILLIAM BARTLETT, M.B., Consulting Aural Surgeon to St. George's Hospital; 18, Savile row. C. 1896-7. V.P. 1901-2. *Trans.* 4.

1891 DALTON, NORMAN, M.D., Physician to King's College Hospital; Professor of Pathological Anatomy in King's College, London; 4, Mansfield street, Cavendish square.

1896 DAUBER, JOHN HENRY, M.A., M.B., B.Ch., Physician to the Hospital for Women, Soho square; 29, Charles street, Berkeley square.

1889 DEAN, HENRY PERCY, M.S., Surgeon to the London Hospital; 69, Harley street, Cavendish square.

1878 DENT, CLINTON THOMAS, Surgeon to, and Lecturer on Surgery at, St. George's Hospital; 61, Brook street. C. 1890. S. 1901—4. *Bldg. Com.* 1890-2. *Cent. Com.* 1904—. *Referee*, 1892—1901. *Trans.* 7.

1891 DE SANTI, PHILIP ROBERT WILLIAM, Assistant Surgeon and Aural Surgeon to the Westminster Hospital; 15, Stratford place. *Trans.* 1.

1894 DICKINSON, THOMAS VINCENT, M.D., Physician to the Italian Hospital, Queen square; 33, Sloane street.

1859 **Dickinson,** WILLIAM HOWSHIP, M.D., Consulting Physician to St. George's Hospital, and Consulting Physician to the Hospital for Sick Children; Honorary Fellow of Caius College, Cambridge; 10, Stanhope place, Marble arch. P. 1896-8. C. 1874-5. V. P. 1887. *Referee*, 1869-73. 1882-6. *Sci. Com.* 1867, 1879, 1889-96. *Trans.* 16.

Elected

1891 **Dickinson**, WILLIAM LEE, M.D., Assistant Physician to St. George's Hospital and to the Hospital for Sick Children; 61, Wimpole street.

1889 DODD, HENRY WORK, Surgeon to the Royal Westminster Ophthalmic Hospital; Ophthalmic Surgeon to the Royal Free Hospital and to the West-End Hospital for Nervous Diseases; 136, Harley street, Cavendish square.

1888 DONELAN, JAMES, M.B., M.C., Physician to the Italian Hospital, Queen square; 6, Manchester square.

1877 DORAN, ALBAN HENRY GRIFFITHS, Surgeon to the Samaritan Free Hospital; 9, Granville place, Portman square. C. 1893-4. *Lib. Com.* 1891-3, 1899—. *Referee*, 1898—. *Trans.* 4.

1891 DOVE, PERCY W., M.B., 80, Crouch hill.

1896 DOWNES, JOSEPH LOCKHART, M.B., C.M., 269, Romford road.

1893 DRYSDALE, JOHN H., M.B., 11, Devonshire place. *Trans.* 1.

1865 **Duckworth**, SIR DYCE, M.D., LL.D., Physician to, and Lecturer on Clinical Medicine at, St. Bartholomew's Hospital; 11, Grafton street, Bond street. C. 1883-4. V.P. 1902-4. *Referee*, 1885-97. *Trans.* 2.

1903 DUDGEON, LEONARD, 6, Powis gardens, Bayswater.

1880 DUNBAR, JAMES JOHN MACWHIRTER, M.D., Hedingham House, Clapham Common.

1884 DUNCAN, WILLIAM, M.D., Obstetric Physician to, and Lecturer on Midwifery at, the Middlesex Hospital; 6, Harley street, Cavendish square.

1887 DUNN, HUGH PERCY, Ophthalmic Surgeon to the West London Hospital; 54, Wimpole street, Cavendish square.

1898 DUNN, L. A., M.S., 51, Devonshire street, Portland place.

1874 DURHAM, FREDERIC, M.B., Consulting Surgeon to the North-West London Hospital; 52, Brook street, Grosvenor square.

Elected

1868 **Eastes**, GEORGE, M.B.Lond., 35, Gloucester terrace, Hyde Park. C. 1892-3.

1893 ECCLES, WILLIAM MCADAM, M.S., Assistant Surgeon, St. Bartholomew's Hospital, to the West London Hospital, and to the City of London Truss Society; 124, Harley street.

1891 EDDOWES, ALFRED, M.D., 28, Wimpole street.

1883 EDMUNDS, WALTER, M.C., 2, Devonshire place, Portland place. *Trans.* 3.

1884 EDWARDS, FREDERICK SWINFORD, Surgeon to the West London Hospital, and to St. Peter's Hospital; Senior Assistant Surgeon to St. Mark's Hospital; 55, Harley street, Cavendish square.

1902 ENGLISH, THOMAS CRISP, 1, Park crescent, Portland place. *Trans.* 1.

1902 EVANS, ARTHUR, M.S., 84, Harley street.

1904 EVANS, JOHN HOWELL, 31, New Cavendish street.

1898 EVANS, WILLMOTT H., M.D., B.S., B.Sc., Assistant Surgeon and Surgeon in charge of Skin Department, Royal Free Hospital; 2, Upper Wimpole street.

1879 EVE, FREDERIC S., Surgeon to the London Hospital; Surgeon to the Evelina Hospital for Sick Children; 125, Harley street, Cavendish square. C. 1897-9. *Referee*, 1902—. *Trans.* 4.

1877 EWART, WILLIAM, M.D., Physician to St. George's Hospital and to the Belgrave Hospital for Children; 33, Curzon street, Mayfair. C. 1895-7. *Lib. Com.* 1897—. *Sci. Com.* 1889-1902. *Trans.* 2. *Pro.* 1.

1900 FAIRBAIRN, JOHN SHIELDS, M.B., Assistant Obstetric Physician to St. Thomas's Hospital; 60, Wimpole street.

1872 FAYRER, SIR JOSEPH, Bart., K.C.S.I., LL.D., M.D., F.R.S., Surgeon-General; Physician Extraordinary to H.M. the King; late Physician to the Secretary of State for India in Council, and President of the Medical Board at the India Office; Kt. of Grace of St. John; 16 Devonshire street, Portland place. C. 1888. *Referee*, 1881-7.

Elected

1902 FENNELL, CHARLES HENRY, M.A., M.D., Tooting Bec Asylum, S.W.

1898 FENWICK, E. HURRY, Surgeon to the London Hospital and to St. Peter's Hospital; 14, Savile row.

1880 FERRIER, DAVID, M.D., LL.D., F.R.S., Professor of Neuropathology in King's College, London, and Physician to King's College Hospital; Physician to the National Hospital for the Paralysed and Epileptic; 34, Cavendish square. *Referee*, 1891-6. C. 1896-8. *Dis. Com.* 1896—. *Trans.* 2.

1900 FLEMMING, PERCY, M.D., B.S., Professor of Ophthalmic Medicine and Surgery in University College, London; Ophthalmic Surgeon to University College Hospital; Assistant Surgeon to the Royal London Ophthalmic Hospital, City road; 31, Wimpole street.

1891 FLETCHER, HERBERT MORLEY, M.D., Assistant Physician, East London Hospital for Children; 98, Harley street, Cavendish square.

1892 FORSBROOK, WILLIAM HENRY RUSSELL, M.D., 40, Lower Belgrave street, Eaton square.

1896 FOULERTON, ALEXANDER GRANT RUSSELL, Middlesex Hospital. *Trans.* 1.

1883 FOWLER, JAMES KINGSTON, M.D., Physician to, and Lecturer on Medicine at, the Middlesex Hospital; Physician to the Hospital for Consumption, Brompton, 35, Clarges street, Piccadilly. C. 1902-3. *Trans.* 1.

1880 FOX, THOMAS COLCOTT, B.A., M.B., Physician for Diseases of the Skin to the Westminster Hospital, and Physician to the Skin Department of the Paddington Green Hospital for Children; 14, Harley street, Cavendish square. C. 1904—. *Trans.* 1.

1871 FRANK, PHILIP, M.D., 3, Elvaston place, South Kensington.

1902 FRENCH, HERBERT, M.D., 26, St. Thomas's street. *Trans.* 1.

1896 FREYER, P. J., M.D., M.Ch., Surgeon to St. Peter's Hospital; 46, Harley street, Cavendish square. *Trans.* 1.

Elected

1898 FRIPP, SIR ALFRED DOWNING, C.B., M.V.O., M.S., Honorary Surgeon-in-Ordinary to H.M. the King; Kt. of Grace of St. John; Assistant Surgeon to Guy's Hospital; 19, Portland place.

1898 FROST, WILLIAM ADAMS, Ophthalmic Surgeon to St. George's Hospital, and Surgeon to Royal Westminster Ophthalmic Hospital; 30, Cavendish square.

1883 FULLER, HENRY ROXBURGH, M.D., 45, Curzon street, Mayfair.

1894 FURNIVALL, PERCY, Assistant Surgeon, London Hospital; Assistant Surgeon, St. Mark's Hospital; 28, Weymouth street, Portland place.

1899 FÜRTH, KARL, M.D., 94, Harley Street.

1874 **Galabin,** ALFRED LEWIS, M.D., Obstetric Physician to, and Lecturer on Midwifery and the Diseases of Women at, Guy's Hospital; 49, Wimpole st., Cavendish square. C. 1892. *Referee,* 1882-91, 1896—. *Lib. Com.* 1883-4. *Trans.* 2.

1895 GALLOWAY, JAMES, M.D., Physician, Skin Department, and Joint Lecturer on Practical Medicine, Charing Cross Hospital; 54, Harley street, Cavendish square.

1865 **Gant,** FREDERICK JAMES, Consulting Surgeon to the Royal Free Hospital; 16, Connaught square, Hyde Park. C. 1880-81. V.P. 1897-9. *Referee,* 1886-97. *Lib. Com.* 1882-5. *Trans.* 3.

1854 **Garrod,** SIR ALFRED BARING, M.D., F.R.S., Physician Extraordinary to Her late Majesty Queen Victoria; Consulting Physician to King's College Hospital; 10, Harley street, Cavendish square. C. 1867. V.P. 1880-81. *Referee,* 1855-65. *Trans.* 9.

Elected

1886 GARROD, ARCHIBALD EDWARD, M.D., Assistant Physician to St. Bartholomew's Hospital; Physician to the Hospital for Sick Children, Great Ormond street; 9, Chandos street, Cavendish square. C. 1902-4. *Sci. Com.* 1889-1902. *Lib. Com.* 1896-1902, 1904—. *Trans.* 7.

1887 GAY, JOHN, 119, Upper Richmond road, Putney.

1866 **Gee,** SAMUEL JONES, M.D., *Chairman of Trustees for Debenture-holders;* Honorary Physician to H.R.H. the Prince of Wales; Physician to St. Bartholomew's Hospital; 31, Upper Brook street, Grosvenor square. C. 1883-4. L. (June) 1887-99. V.P. 1899-1900. *Sci. Com.* 1879. *Bldg. Com.* 1889-92. *Referee,* 1885-7, 1900—. *Lib. Com.* 1871-6. *Ho. Com.* 1898-1900. *Trans.* 1.

1898 GIBBES, CUTHBERT CHAPMAN, M.D., 89, Harley street.

1880 GIBBONS, ROBERT ALEXANDER, M.D., Physician to the Grosvenor Hospital for Women and Children; 29, Cadogan place. C. 1896-7. *Trans.* 1.

1893 GILES, ARTHUR EDWARD, M.D., B.Sc., Assistant Surgeon, Chelsea Hospital for Women; 10, Upper Wimpole street.

1894 GILL, RICHARD, 72, Wimpole street.

1877 GODLEE, RICKMAN JOHN, M.S., *Hon. Librarian;* Honorary Surgeon-in-Ordinary to H.M. the King; Surgeon to University College Hospital, and Professor of Clinical Surgery in University College, London; Surgeon to the Hospital for Consumption, Brompton; 19, Wimpole street, Cavendish square. S. 1892-4. L. 1895—. *Referee,* 1886-91. *Ho. Com.* 1898—. *Trans.* 11.

1870 **Godson,** CLEMENT, M.D., Consulting Physician to the City of London Lying-in Hospital; 82, Brook street, Grosvenor square.

Elected

1886 GOLDING-BIRD, CUTHBERT HILTON, M.B., Surgeon to, and Lecturer on Clinical Surgery at, Guy's Hospital; 12, Queen Anne street, Cavendish square. *Trans.* 1.

1897 GOODBODY, F. W., M.D., 6, Chandos street, Cavendish square.

1896 GOODALL, EDWARD WILBERFORCE, M.D., B.S., Eastern Hospital, Homerton.

1883 GOODHART, JAMES FREDERIC, M.D., Physician to Guy's Hospital; Consulting Physician to the Evelina Hospital for Sick Children; 25, Portland place. C. 1903—4. *Referee*, 1900-3. *Lib. Com.* 1893-6.

1889 GOODSALL, DAVID HENRY, Surgeon to the Metropolitan Hospital; Surgeon to St. Mark's Hospital; 17, Devonshire place, Upper Wimpole street.

1895 GOSSAGE, ALFRED MILNE, M.B., 54, Upper Berkeley street.

1877 GOULD, ALFRED PEARCE, M.S., Surgeon to, and Lecturer on Surgical Pathology at, the Middlesex Hospital; 10, Queen Anne street, Cavendish square. C. 1892-3. S. 1898—1901. V.P. 1904—. *Referee*, 1895-8. *Ho. Com.* 1892-8, 1904—. *Lib. Com.* 1891. *Cent. Com.* 1904—. *Trans.* 3.

1891 GOW, WILLIAM J., M.D., Assistant Obstetric Physician to St. Mary's Hospital; Obstetric Physician to the Royal Hospital for Women and Children; Physician to Out-Patients, Queen Charlotte's Lying-in Hospital; 27, Weymouth street, Portland place.

1873 **Gowers**, SIR WILLIAM RICHARD, M.D., F.R.S., Consulting Physician to University College Hospital; Physician to the National Hospital for the Paralysed and Epileptic; 50, Queen Anne street, Cavendish square. C. 1891. *Referee*, 1888-90. *Lib. Com.* 1884-6. *Trans.* 7.

1892 GRANT, J. DUNDAS, M.A., M.D., 18, Cavendish square.

1868 GREEN, T. HENRY, M.D., Physician to the Charing Cross Hospital, and to the Hospital for Consumption, Brompton; 74, Wimpole street, Cavendish square. C. 1886. *Referee*, 1882-5.

Elected

1885 GRIFFITH, WALTER SPENCER ANDERSON, M.D., Assistant Physician-Accoucheur, St. Bartholomew's Hospital; Physician to Queen Charlotte's Lying-in Hospital; 96, Harley street, Cavendish square. *Referee*, 1902—.

1903 GRÜNBAUM, OTTO F. F., M.B., B.C., 30A, Wimpole street, Cavendish square.

1883 GUNN, ROBERT MARCUS, M.B., Surgeon to the Royal London Ophthalmic Hospital, Moorfields; Ophthalmic Surgeon to the National Hospital for the Paralysed and Epileptic; 54, Queen Anne street, Cavendish square. C. 1903-4.

1890 GUTHRIE, LEONARD GEORGE, M.D., B.Ch., Physician to the Regent's Park Hospital for Epilepsy and Paralysis; Assistant Physician to the North-West London Hospital; Assistant Physician to the Children's Hospital, Paddington Green; 15, Upper Berkeley street, Portman square.

1886 HABERSHON, SAMUEL HERBERT, M.D., Assistant Physician to the Hospital for Consumption, Brompton; 88, Harley street, Cavendish square.

1885 HAIG, ALEXANDER, M.D., Physician to the Metropolitan Hospital, and to the Royal Hospital for Children and Women; 7, Brook street, Grosvenor square. *Trans.* 6.

1890 HALE, CHARLES DOUGLAS BOWDICH, M.D., 3, Sussex place, Hyde Park.

1881 **Hall**, FRANCIS DE HAVILLAND, M.D., Physician to, and Joint Lecturer on Medicine at, the Westminster Hospital; 47, Wimpole street, Cavendish square. C. 1901-3. *Referee*, 1893-7.

1891 HAMER, WILLIAM HEATON, M.D., 1A, Bramshill gardens, Dartmouth park hill, Highgate.

Elected

1889 HANDFIELD-JONES, MONTAGU, M.D., Obstetric Physician to, and Lecturer on Midwifery and Diseases of Women at, St. Mary's Hospital; Physician to the British Lying-in Hospital; 35, Cavendish square.

1893 **Harley,** VAUGHAN, M.D., 25, Harley street, Cavendish square.

1901 HARMER, WILLIAM DOUGLAS, M.B., The Warden's House, St. Bartholomew's Hospital.

1892 HAROLD, JOHN, M.B., 91, Harley street, Cavendish square.

1870 HARRISON, REGINALD, Surgeon to St. Peter's Hospital; 6, Lower Berkeley street, Portman square. C. 1894-5. V.-P. 1898-1900. *Trans.* 4.

1870 **Haward,** J. WARRINGTON, *Hon. Treasurer;* Consulting Surgeon to, and Lecturer on Clinical Surgery at, St. George's Hospital; 57, Green street, Grosvenor Square. C.1885. S. 1888-91. V.P. 1894-5. T. (June) 1895—. *Lib. Com.* 1881-4. *Sci. Com.* 1889-91. *Bldg. Com.* (*Sec.*) 1889-92. *Ho. Com.* 1892—. *Trans.* 3.

1891 HAWKINS, HERBERT PENNELL, M.D., B.Ch., Physician to St. Thomas's Hospital; 56, Portland place.

1875 HAYES, THOMAS CRAWFORD, M.D., Physician-Accoucheur and Physician for Diseases of Women and Children to King's College Hospital, and Professor of Midwifery in King's College; Physician for Diseases of Women to the Royal Free Hospital; 17, Clarges street, Piccadilly.

1891 HAYWARD, JOHN ARTHUR, M.D., 23, The Grange, Wimbledon Common. *Pro.* 1.

Elected

1865 **Heath,** CHRISTOPHER, Emeritus Professor of Clinical Surgery in University College, London; and Consulting Surgeon to University College Hospital; 36, Cavendish square. C. 1880. V.P. 1889. *Lib. Com.* 1870-3. *Trans.* 4.

1895 HENDERSON, EDWARD ERSKINE, B.A., M.B., B.C., 20, Queen Anne street, Cavendish square.

1901 HENRY, JOHN PATRICK, M.D., B.Ch., Ophthalmic Surgeon to the Italian Hospital, Queen square; Oculist to the London School Board; 41, Welbeck street, Cavendish square.

1882 HENSLEY, PHILIP JOHN, M.D., Physician to, and Lecturer on Forensic Medicine at, St. Bartholomew's Hospital; 4, Henrietta street, Cavendish square. *Referee,* 1897—1904.

1877 HERMAN, GEORGE ERNEST, M.B., Consulting Obstetric Physician to the London Hospital; 20, Harley street, Cavendish square. C. 1900-2. *Referee,* 1892-1900. *Lib. Com.* 1898-1900. *Trans.* 1.

1900 HERN, WILLIAM, 7, Stratford place.

1877 HERON, GEORGE ALLAN, M.D., Physician to the City of London Hospital for Diseases of the Chest, Victoria Park; 57, Harley street, Cavendish square. C. 1904—. *Ho. Com.* 1904—.

1891 HERRING, HERBERT T., M.B., B.S., 50, Harley street, Cavendish square.

1883 HERRINGHAM, WILMOT PARKER, M.D., Assistant Physician, St. Bartholomew's Hospital; 40, Wimpole street, Cavendish square. C. 1903—4. *Lib. Com.* 1902-3, 1904—. *Ho. Com.* 1903—4. *Trans.* 3.

1893 HERSCHELL, GEORGE, M.D., 36, Harley street, Cavendish square.

Elected

1887 HEWITT, FREDERIC WILLIAM, M.V.O., M.D., Honorary Anæsthetist to H.M. the King; Anæsthetist to, and Instructor in Anæsthetics at, the London Hospital; Anæsthetist at the Dental Hospital of London; 14, Queen Anne street, Cavendish square. *Trans.* 3.

1890 HILL, G. WILLIAM, M.D., B.Sc., 26, Weymouth street, Portland place.

1899 HILLIER, ALFRED P., M.D., 30, Wimpole street.

1856 **Holmes**, TIMOTHY, M.C., M.A., Consulting Surgeon to St. George's Hospital; Corresponding Member of the Société de Chirurgie, Paris; 6, Sussex place, Hyde Park. C. 1869-70. L. 1873-7. S. 1878-80. V.P. 1881-2. T. 1885-7. P. 1890-92. *Bldg.Com.* (*Chairman*) 1889-92. *Referee*, 1866-8, 1872, 1883-4. *Sci. Com.* 1867. *Lib. Com.* 1863-5, 1892-5. *Ho. Com.* 1892-8. *Trans.* 8.

1878 HOOD, DONALD WILLIAM CHARLES, C.V.O., M.D., Senior Physician to the West London Hospital; Examining Physician for King's Messengers, Foreign Office; 43, Green street, Park lane. C. 1904—.

1898 HORDER, THOMAS J., M.D., 141, Harley street.

1883 HORSLEY, SIR VICTOR ALEXANDER HADEN, F.R.S., Surgeon to University College Hospital, Surgeon to the National Hospital for the Paralysed and Epileptic; 25, Cavendish square. *Referee*, 1897—. *Trans.* 1.

1896 HORTON-SMITH, PERCIVAL, M.D., 19, Devonshire street, Portland place. *Sci. Com.* 1897-1902. *Trans.* 1.

1892 HOWARD, R. J. BLISS, M.D., 31, Queen Anne street, Cavendish square.

1874 HOWSE, SIR HENRY GREENWAY, M.S., Surgeon to, and Lecturer on Surgery at, Guy's Hospital; Consulting Surgeon to the Evelina Hospital for Sick Children; 22, Grosvenor street, Grosvenor square. C. 1890. V.P. 1899-1901. *Sci. Com.* 1879. *Referee*, 1887-9. *Trans.* 3.

Elected

1902 HULBERT, ERNEST BEDDOE, M.D., 77, Welbeck street, Cavendish square.

1903 HULBERT, HENRY LOUIS POWELL, M.A., M.B., B.C., The Vicarage, Towcester, Northants.

1889 HUNTER, WILLIAM, M.D., Senior Assistant Physician to the London Fever Hospital; Curator and Pathologist, Charing Cross Hospital; 103, Harley street.

1856 **Hutchinson,** JONATHAN, F.R.S., Consulting Surgeon to, and Emeritus Professor of Surgery at, the London Hospital; Consulting Surgeon to the Royal London Ophthalmic Hospital, Moorfields, and Senior Surgeon to the Hospital for Diseases of the Skin; 15, Cavendish square. C. 1870. V.P. 1882. P. 1894-6. *Referee,* 1876-81, 1883-94. *Lib. Com.* 1864-5. *Trans.* 15. *Pro.* 2.

1888 HUTCHINSON, JONATHAN, Jun., Surgeon to the London Hospital; 1, Park crescent. *Trans.* 3.

1897 HUTCHISON, ROBERT, M.D., 22, Queen Anne street, Cavendish square.

1871 JACKSON, J. HUGHLINGS, M.D., LL.D., F.R.S., Consulting Physician to the London Hospital; Physician to the National Hospital for the Paralysed and Epileptic; 3, Manchester square. C. 1889.

1883 JESSOP, WALTER H. H., M.B., Ophthalmic Surgeon to St. Bartholomew's Hospital; 73, Harley street. *Referee,* 1901.

1881 JOHNSON, GEORGE LINDSAY, M.D., Cortina, Netherhall gardens, South Hampstead, and 36, Finsbury pavement.

1889 JOHNSON, HAROLD JOSSÉ, 29, Gracechurch street, E.C.

1889 JOHNSON, RAYMOND, M.B., B.S., Assistant Surgeon to University College Hospital; Surgeon to the Victoria Hospital for Children; 11, Wimpole street, Cavendish square. *Trans.* 1.

1884 JOHNSTON, JAMES, M.D., 53, Prince's square, Bayswater

Elected

1899 **Jones**, GEORGE, M.B., 8, Church terrace, Lee.

1887 JONES, HENRY LEWIS, M.D., Medical Officer in charge of Electrical Department at St. Bartholomew's Hospital 143, Harley street, Cavendish square.

1896 JONES, L. VERNON, B.A., M.D., B.Ch., 7, Arlington street, St. James's.

1881 JULER, HENRY EDWARD, Ophthalmic Surgeon to St. Mary's Hospital; Surgeon to the Royal Westminster Ophthalmic Hospital; Consulting Ophthalmic Surgeon to the London Lock Hospital; 23, Cavendish square. C. 1901-3. *Ho. Com.* 1902-3.

1898 KEEP, A. CORRIE, M.D., C.M., Surgeon to out-patients Samaritan Free Hospital for Women and Children; 14, Gloucester place, Portman square.

1882 KEETLEY, CHARLES R. B., Senior Surgeon to the West London Hospital; 56, Grosvenor street, Grosvenor square. C. 1901-3. *Lib. Com.* 1903—. *Trans.* 1.

1898 KELLOCK, THOMAS HERBERT, M.D., B.C., Assistant Surgeon to Middlesex Hospital and to the Hospital for Sick Children; 8, Queen Anne street, Cavendish square.

1901 KELYNACK, T. N., M.D., 120, Harley street.

1902 KERR, JAMES, M.D., D.P.H., School Board for London, Victoria Embankment.

1857 **Kiallmark**, HENRY WALTER, 5, Pembridge gardens. C. 1890–91.

1881 KIDD, PERCY, M.D., Physician to the Hospital for Consumption, Brompton; Physician to the London Hospital; 60, Brook street, Grosvenor square. C. 1900-2. *Trans.* 4.

1902 KING, DAVID BARTY, M.A., M.D., Ch.B., 13, Queen street, Mayfair.

Elected

1851 **Kingdon**, JOHN ABERNETHY, Consulting Surgeon to the Bank of England, Threadneedle street. C. 1866-7. V.P. 1872-3. *Sci. Com.* 1867. *Trans.* 1.

1900 LAKE, RICHARD, Surgeon Laryngologist, Mount Vernon Hospital for Consumption; Surgeon, Royal Ear Hospital; 19, Harley street. *Trans.* 1.

1896 LANE, JAMES ERNEST, Surgeon to Out-patients, St. Mary's Hospital; 46, Queen Anne Street, Cavendish square.

1884 LANE, WILLIAM ARBUTHNOT, M.S., Surgeon to Guy's Hospital and to the Hospital for Sick Children, 21, Cavendish square. C. 1904—. *Trans.* 4.

1882 LANG, WILLIAM, Ophthalmic Surgeon to, and Lecturer on Ophthalmic Surgery at, the Middlesex Hospital; Surgeon to the Royal London Ophthalmic Hospital, Moorfields; 22, Cavendish square. C. 1904—.

1894 LANGDON-DOWN, REGINALD LANGDON, M.B., B.C., 47, Welbeck street.

1865 **Langton**, JOHN, Surgeon to, and Lecturer on Clinical Surgery at, St. Bartholomew's Hospital; Surgeon to the City of London Truss Society; 62, Harley street, Cavendish square. C. 1881–2. V.P. 1895-7, *Referee*, 1885-95. *Lib. Com.* 1879-80, 1888-95, *Trans.* 2.

1898 LATHAM, A. C., M.D., 44, Brook street, Grosvenor square.

1890 LAW, EDWARD, M.D., C.M., 8, Wimpole street, Cavendish square.

1898 LAWFORD, J. B., Ophthalmic Surgeon and Lecturer on Ophthalmology, St. Thomas's Hospital; Surgeon to Royal London Ophthalmic Hospital; 99, Harley street.

1888 LAWRENCE, LAURIE ASHER, 9, Upper Wimpole street.

Elected

1890 LAWRIE, EDWARD, M.B., Surgeon Lieutenant-Colonel, Indian Medical Department; late Residency Surgeon, Hyderabad, Deccan; Harley Lodge, 115A, Harley street.

1893 LAWSON, ARNOLD, Ophthalmic Surgeon to the Children's Hospital, Paddington Green; 12, Harley street, Cavendish square.

1900 LEAF, CECIL HUNTINGTON, M.A., M.B.; 75, Wimpole street, Cavendish square.

1896 LEE, WILLIAM EDWARD, M.D., 36, Finsbury pavement.

1895 LEES, DAVID BRIDGE, M.D., Physician to, and Lecturer on Medicine at, St. Mary's Hospital, and Physician to the Hospital for Sick Children; 22, Weymouth street, Portland place. *Trans.* 2.

1899 LEGGE, THOMAS MORISON, M.D., 2, Mitre court buildings, Temple.

1895 LESLIE, ROBERT MURRAY, M.B., Assistant Physician to Royal Hospital for Diseases of the Chest; 26, Harley street, Cavendish square.

1897 LEVY, ALFRED G., M.D., 41, Devonshire street, Portland place.

1886 LEWERS, ARTHUR HAMILTON NICHOLSON, M.D., Obstetric Physician to the London Hospital; 72, Harley street, Cavendish square. *Trans.* 1.

1878 LISTER, RIGHT HON. LORD, P.C., O.M., D.C.L., LL.D., F.R.S., Sergeant-Surgeon in Ordinary to H.M. the King; Emeritus Professor of Clinical Surgery in King's College, London; and Consulting Surgeon to King's College Hospital; 12, Park crescent, Regent's Park. C. 1892.

1891 LITTLE, ERNEST MUIRHEAD, Surgeon to the National Orthopædic Hospital; 40, Seymour street, Portman square.

Elected

1889 LITTLE, JOHN FLETCHER, M.B., 32, Harley street, Cavendish square.

1881 LOCKWOOD, CHARLES BARRETT, Surgeon to the Great Northern Central Hospital; Assistant Surgeon to, and Lecturer on Surgical and Descriptive Anatomy at, St. Bartholomew's Hospital; 19, Upper Berkeley street, Portman square. C. 1901-3. *Trans.* 5.

1897 LOW, HAROLD, 10, Evelyn gardens.

1881 LUCAS, RICHARD CLEMENT, B.S., M.B., Surgeon to, and Lecturer on Surgery, late Lecturer on Anatomy at, Guy's Hospital; Consulting Surgeon to the Evelina Hospital for Sick Children; 50, Wimpole street, Cavendish square. C. 1900-2. *Ho. Com.* 1901-2. *Trans.* 3.

1888 LUFF, ARTHUR PEARSON, M.D., B.Sc., Physician to Outpatients and Lecturer on Medical Jurisprudence at St. Mary's Hospital; 9, Queen Anne street, Cavendish square. *Referee*, 1903—. *Trans.* 1.

1887 LUSH, PERCY J. F., M.B., 4, Maresfield gardens, Hampstead.

1898 LYSTER, C. R. C., Bolingbroke Hospital, Wandsworth common.

1873 **MacCarthy**, JEREMIAH, M.A., Consulting Surgeon to the London Hospital, late Lecturer on Surgery at the London Hospital Medical College; 1, Cambridge place, Victoria road, Kensington. C. 1886-7. *Lib. Com.* 1882-5. *Referee*, 1890—.

1899 MACDONALD, GREVILLE, M.D., 85, Harley street.

1898 MCFADYEAN, JOHN, The Royal Veterinary College, Camden Town.

1894 MACFADYEN, ALLAN, M.D., C.M., Lister Institute of Preventive Medicine, Chelsea bridge.

Elected

1880 McHARDY, MALCOLM MACDONALD, Ophthalmic Surgeon to King's College Hospital, and Professor of Ophthalmic Surgery in King's College, London; Senior Surgeon to the Royal Eye Hospital, Southwark; 5, Savile row.

1902 MACKENZIE, HECTOR WILLIAM GAVIN, M.A., M.D., 34, Upper Brook street.

1881 MACKENZIE, SIR STEPHEN, M.D., Physician to the London Hospital; Physician to the Royal London Ophthalmic Hospital; 18, Cavendish square. C. 1899-1900. *Referee*, 1890-9. *Trans.* 1.

1881 MACREADY, JONATHAN FORSTER CHRISTIAN HORACE, Surgeon to the Great Northern Hospital; 42, Devonshire street.

1880 MADDICK, EDMUND DISTIN, 31, Cavendish square.

1886 MAGUIRE, ROBERT, M.D., Physician to Out-patients and Joint Lecturer on Pathology at St. Mary's Hospital; Physician to the Hospital for Consumption, Brompton; 4, Seymour street, Portman square. *Sci. Com.* 1889-1902.

1880 MAKINS, GEORGE HENRY, C.B., Surgeon to St. Thomas's Hospital; Consulting Surgeon to the Evelina Hospital for Children; 47, Charles street, Berkeley square. C. 1899-1900. *Referee*, 1898-9, 1902—. *Trans.* 2.

1885 MALCOLM, JOHN DAVID, M.B., C.M., Surgeon to the Samaritan Free Hospital; 13, Portman street, Portman square. *Trans.* 2.

1890 MANSON, SIR PATRICK, K.C.M.G., M.D., C.M., LL.D., F.R.S., Physician to the Seamen's Hospital, Albert Docks; Lecturer on Tropical Medicine at St. George's Hospital; 21, Queen Anne street, Cavendish square. *Referee*, 1904—.

1867 MARSH, F. HOWARD, Professor of Surgery, University of Cambridge, late Surgeon to, and Lecturer on Surgery at, St. Bartholomew's Hospital; 14, Hertford street, Mayfair. C. 1882-3, 1889. S. 1885-7. V.P. 1891-3. *Lib. Com.* 1880-1. *Trans.* 4.

Elected

1891 MARTIN, HENRY CHARRINGTON, M.D., 27, Oxford square.

1884 MARTIN, SIDNEY HARRIS COX, M.D., F.R.S., Assistant Physician to University College Hospital, and to the Hospital for Consumption, Brompton; Professor of Pathology, University College, London; 10, Mansfield street, Portland place. *Referee*, 1904—.

1892 MASTERS, JOHN ALFRED, M.D., 94, Knightsbridge.

1891 MAY, WILLIAM PAGE, M.D., B.Sc., 9, Manchester square.

1880 MEREDITH, WILLIAM APPLETON, M.B., C.M., Surgeon to the Samaritan Free Hospital for Women and Children; 21, Manchester square. C. 1897-9. *Ho. Com.* 1898-9. *Trans.* 1.

1894 MICHELS, ERNST, M.D., Surgeon to the German Hospital; 48, Finsbury square. *Trans.* 2.

1893 MILEY, MILES, M.B., 21, Belsize avenue, Hampstead.

1891 MOLINE, PAUL, M.B., 42, Walton street, Chelsea.

1873 MOORE, NORMAN, M.D., *Hon. Librarian*, Physician and Lecturer on Medicine to St. Bartholomew's Hospital; 94, Gloucester place, Portman square. C. 1891-2. L. 1899—. S. 1896-9. *Referee*, 1886-90. *Ho. Com.* 1898—. *Sci. Com.* 1889-1902. *Cent. Com.* 1904—.

1878 MORGAN, JOHN HAMMOND, C.V.O., M.A., Surgeon to the Charing Cross Hospital, and to the Hospital for Sick Children, Great Ormond street; 68, Grosvenor street. C. 1895-7. *Dis. Com.* 1896-7. *Referee*, 1901—. *Trans.* 2.

1894 MORISON, ALEXANDER, M.D., 14, Upper Berkeley street.

1874 **Morris**, HENRY, M.A., Surgeon to the Middlesex Hospital; 8, Cavendish square. C. 1888-9. V.P. 1900-2. *Referee*, 1882-7. *Lib. Com.* 1895-6. *Trans.* 10.

Elected

1879 MORRIS, MALCOLM ALEXANDER, Consulting Surgeon to the Skin Department of, and late Lecturer on Dermatology at, St. Mary's Hospital; 8, Harley street, Cavendish square. *Sci. Com.* 1889-1902. *Trans.* 1.

1898 MORRISON, JAMES, M.D., 11, Brook street, Grosvenor square.

1885 MOTT, FREDERICK WALKER, M.D., F.R.S., Assistant Physician, Charing Cross Hospital; Pathologist to the London County Council; 25, Nottingham place. *Referee*, 1900—. *Sci. Com.* 1899—. *Trans.* 1.

1902 MUMMERY, JOHN PERCY LOCKHART, B.A., 10, Cavendish place.

1900 MURPHY, WILLIAM REID, D.S.O., Lieutenant-Colonel I.M.S.; East India and Colonial Club, 16, St. James's street.

1896 **Murphy,** JAMES KEOGH, M.B., M.C., St. Bartholomew's Hospital.

1888 **Murray,** HUBERT MONTAGUE, M.D., Physician to, and Joint Lecturer on Medicine at, the Charing Cross Hospital; Physician to the Victoria Hospital for Children; 25, Manchester square.

1898 MURRAY, JOHN, Assistant Surgeon to the Middlesex Hospital and to the Paddington Green Children's Hospital; 110, Harley street.

1880 MURRELL, WILLIAM, M.D., Physician to, Lecturer on Clinical Medicine, and Joint Lecturer on Medicine at the Westminster Hospital; 17, Welbeck street, Cavendish square. *Sci. Com.* 1889-1902. *Trans.* 1.

1863 **Myers,** ARTHUR BOWEN RICHARDS, late Brigade-Surgeon, Brigade of Guards; 43, Gloucester street, Warwick square. C. 1878-9. *Lib. Com.* 1877.

1904 NESS, THOMAS MATHESON, M.B., 11, Clifford street, Bond street.

Elected

1864 **Nunn**, THOMAS WILLIAM, Consulting Surgeon to the Middlesex Hospital; 27, York terrace, York gate.

1880 OGILVIE, GEORGE, M.B., B.Sc., Physician to the French Hospital, and to the Hospital for Epilepsy and Paralysis, Maida Vale; 22, Welbeck street, Cavendish square. *Trans.* 1.

1891 OGLE, CYRIL, M.A., M.B., Assistant Physician to St. George's Hospital; 96, Gloucester place, Portman square.

1858 **Ogle**, JOHN WILLIAM, M.D., Consulting Physician to St. George's Hospital; 96, Gloucester place, Portman square. C. 1873. V.P. 1886. *Referee*, 1864-72. *Trans.* 4.

1860 OGLE, WILLIAM, M.D., late Superintendent of Statistics in the Registrar-General's Department, Somerset House; 10, Gordon street, Gordon square. *Marshall Hall Trustee*, 1873-1903. S. 1868-70. C. 1876-7. V.P. 1887. *Lib. Com.* 1871-5. *Trans.* 5.

1892 OPENSHAW, T. HORROCKS, C.M.G., M.B., M.S., Surgeon to, and Lecturer on Anatomy at, the London Hospital; 16, Wimpole street, Cavendish square.

1877 ORMEROD, JOSEPH ARDERNE, M.D., Assistant Physician to St. Bartholomew's Hospital; Physician to the National Hospital for the Paralysed and Epileptic, Queen square; 25, Upper Wimpole street. C. 1897. *Lib. Com.* 1896-7. *Trans.* 1.

1879 OWEN, EDMUND, M.B., Consulting Surgeon to St. Mary's Hospital; Consulting Surgeon to the Hospital for Sick Children, Great Ormond street; Surgeon-in-chief to the French Hospital; 64, Great Cumberland place, Hyde park. C. 1896-7. *Trans.* 4.

1882 OWEN, SIR ISAMBARD, M.D., Deputy-Chancellor of the University of Wales; Physician to, and Lecturer on Forensic Medicine at, St. George's Hospital; 40, Curzon street, Mayfair. C. 1902-3. *Bldg. Com.* 1889-92. *Referee*, 1893, 1895-1902.

Elected

1892 PAGE, H. MARMADUKE, 14. Grenville place, South Kensington.

1874 PAGE, HERBERT WILLIAM, M.A., M.C., Surgeon to, and Joint Lecturer on Surgery at, St. Mary's Hospital; 146, Harley street, Cavendish square. C. 1890-91. *Referee*, 1884-9. *Lib. Com.* 1886-8. *Trans.* 4.

1886 PAGET, STEPHEN, *Hon. Secretary*, Surgeon to the West London Hospital; Surgeon to the Throat and Ear Department of the Middlesex Hospital; 70, Harley street. S. 1904—. *Lib. Com.* 1902—4.

1895 PARKER, CHARLES ARTHUR, 141, Harley street, Cavendish square.

1889 PARSONS, J. INGLIS, M.D., Physician to the Chelsea Hospital for Women; 3, Queen street, Mayfair.

1883 PASTEUR, WILLIAM, M.D., Physician to the Middlesex Hospital; Consulting Physician to the North-Eastern Hospital for Children; 4, Chandos street, Cavendish square.

1901 PATERSON, HERBERT JOHN, 9, Upper Wimpole street.

1891 PATERSON, WILLIAM BROMFIELD, 7A, Manchester square.

1891 PATON, EDWARD PERCY, M.D., M.S., 84, Park street, Grosvenor square.

1865 **Pavy**, FREDERICK WILLIAM, M.D., LL.D., F.R.S., Consulting Physician to Guy's Hospital; 35, Grosvenor street. P. 1900-2. C. 1883-4. V.P. 1893-4. *Referee*, 1871-82. *Trans.* 1.

1869 PAYNE, JOSEPH FRANK, M.D., Physician to, and Lecturer on Medicine at, St. Thomas's Hospital; 78, Wimpole street, Cavendish square. C. 1887. *Referee*, 1890—. *Sci. Com.* 1879. *Lib. Com.* 1878-85, 1889—.

1903 PEARSON, S. VERE, M.B., 31, Grosvenor street.

Elected

1894 PEGLER, L. HEMINGTON, M.D., 58, Harley street.

1898 PENDLEBURY, HERBERT STRINGFELLOW, M.B., B.C., 44, Brook street, Grosvenor square.

1887 PENROSE, FRANCIS GEORGE, M.D., Physician to St. George's Hospital and to the Hospital for Sick Children, Great Ormond street; 84, Wimpole street, Cavendish square. *Sci. Com.* 1889-1902.

1890 PERRY, SIR EDWIN COOPER, M.D., Physician to, and Demonstrator of Pathology at, Guy's Hospital; The Superintendent's House, Guy's Hospital.

1895 PHEAR, ARTHUR G., M.D., Assistant Physician and Pathologist to the Metropolitan Hospital; 47, Weymouth street, Portland place. *Trans.* 2.

1883 PHILLIPS, CHARLES DOUGLAS F., M.D., LL.D., 10, Henrietta street, Cavendish square.

1884 PHILLIPS, GEORGE RICHARD TURNER, J.P., 28, Palace Court, Bayswater hill.

1889 PHILLIPS, SIDNEY, M.D., Physician and Lecturer on Medicine at St. Mary's Hospital; Senior Physician to the London Fever Hospital, and to the Lock Hospital; 62, Upper Berkeley street, Portman square. *Trans.* 1.

1884 PITT, GEORGE NEWTON, M.D., *Hon. Secretary*, Physician to, and Pathologist at, Guy's Hospital; 15, Portland place. S. 1902—. *Referee*, 1897-1902. *Trans.* 1.

1889 PITTS, BERNARD, M.A., M.C., Surgeon to St. Thomas's Hospital and Lecturer on Surgery; Surgeon to the Hospital for Sick Children, Great Ormond street; 109, Harley street, Cavendish square. *Referee*, 1897—.

1901 PLIMMER, HENRY GEORGE, 16, Cheyne walk, Chelsea.

Elected

1885 POLAND, JOHN, Surgeon to the City Orthopædic Hospital and Miller Hospital, Greenwich; 2, Mansfield street, Cavendish square.

1884 POLLARD, BILTON, B.S., Surgeon to University College Hospital; Consulting Surgeon to the North-Eastern Hospital for Children; 24, Harley street, Cavendish square. *Trans.* 1.

1865 **Pollock,** JAMES EDWARD, M.D., Consulting Physician to the Hospital for Consumption, Brompton; 37, Collingham place. C. 1882-3. V.P. 1896-7. *Referee,* 1872-81.

1894 POLLOCK, WILLIAM RIVERS, M.B., B.C., Assistant Obstetric Physician to the Westminster Hospital; 56, Park street, Grosvenor square.

1867 POWELL, SIR RICHARD DOUGLAS, Bart., K.C.V.O., M.D., *President,* Physician Extraordinary to H.M. the King; Consulting Physician to, and late Lecturer on Medicine at, the Middlesex Hospital; Consulting Physician to the Hospital for Consumption, Brompton; 62, Wimpole street, Cavendish square. P. 1904—. S. (Oct.) 1883-5. C. 1887-8. V.P. 1902-4. *Referee,* 1879-83, 1886. *Trans.* 3.

1887 POWER, D'ARCY, M.A., M.B., Assistant Surgeon at St. Bartholomew's Hospital; Surgeon to the Victoria Hospital for Children, Chelsea; 10A, Chandos street, Cavendish Square. *Lib. Com.* 1896—. *Trans.* 3.

1867 **Power,** HENRY, Consulting Ophthalmic Surgeon to St. Bartholomew's Hospital; 10A, Chandos street, Cavendish square, and Bagdale Hall, Whitby. C. 1882-3. V.P. 1892-3. *Referee,* 1870-81, 1891-2. *Sci. Com.* 1870, 1889—. *Lib. Com.* 1872-8.

1883 PRINGLE, JOHN JAMES, M.B., C.M., Physician in Charge of Skin Department at the Middlesex Hospital; 23, Lower Seymour street, Portman square. *Trans.* 2.

Elected

1874 PURVES, WILLIAM LAIDLAW, Aural Surgeon to Guy's Hospital ; 20, Stratford place, Oxford street. *Trans.* 2.

1877 PYE-SMITH, PHILIP HENRY, M.D., F.R.S., Physician to and Lecturer on Medicine at, Guy's Hospital; 48, Brook street, Grosvenor square. C. 1893-4. *Lib. Com.* 1887-93, 1899—. *Referee*, 1897—. *Trans.* 1.

1898 RAMSAY, HERBERT MURRAY, 35A, Hertford street.

1893 RANKIN, GUTHRIE, M.D., 4, Chesham street, Belgrave square. *Trans.* 1.

1899 RAWLING, LOUIS BATHE, M.B., B.C., 16, Montagu street, Portman square.

1892 RAYNER, HENRY, M.D., Lecturer on Psychological Medicine to St. Thomas's Hospital ; 16, Queen Anne street, Cavendish square.

1869 READ, THOMAS LAURENCE, 11, Petersham terrace, Queen's gate. C. 1901-3. *Ho. Com.* 1902-3.

1891 REECE, RICHARD JAMES, 62, Addison gardens.

1882 REID, SIR JAMES, Bart., G.C.V.O., K.C.B., M.D., Physician-in-Ordinary to H.M. the King ; 72, Grosvenor street, Grosvenor square. C. 1904—. *Cent. Com.* 1904—.

1891 RENDEL, ARTHUR BOWEN, M.A., M.B., B.C., 43, Albion street, Hyde Park.

1903 RICH, EVELYN ARTHUR, 12, Carlisle mansions, Carlisle place.

1887 RICHARDSON, GILBERT, M.A., M.D., 19, Putney hill.

1863 RINGER, SYDNEY, M.D., F.R.S., Holme Professor of Clinical Medicine in University College, London, and Physician to University College Hospital ; 15, Cavendish place, Cavendish square. C. 1881-2. V.P. 1900-2. *Referee*, 1873-80, 1889-97. *Trans.* 6.

Elected

1900 RIVIERE, CLIVE, M.D., 19, Devonshire street, Portland place. *Trans.* 1.

1896 ROBERTS, CHARLES HUBERT, M.D., Physician to Out-Patients, Samaritan Hospital for Women; Physician to Out-patients, Queen Charlotte's Lying-in Hospital, London; 21, Welbeck street.

1893 ROBERTS, D. WATKIN, M.D., 56, Manchester street, Manchester square.

1878 ROBERTS, FREDERICK THOMAS, M.D., Professor of Medicine, and of Clinical Medicine, in University College, London; Physician to University College Hospital; Consulting Physician to the Hospital for Consumption, Brompton; 102, Harley street, Cavendish square. C. 1894-5. *Referee*, 1899—. *Sci. Com.* 1889-1902.

1898 ROBERTSON, F. W., M.D., "Ravenstone," Lingfield road, Wimbledon, Surrey.

1901 ROBINSON, GEORGE HENKELL DRUMMOND, M.D., 84, Park street, Grosvenor square.

1896 ROBINSON, HENRY BETHAM, M.S., Assistant Surgeon to, and Surgeon in Charge of the Throat Department, St. Thomas's Hospital; Assistant Surgeon to the East London Hospital for Children, Shadwell; 1, Upper Wimpole street. *Trans.* 1.

1889 ROBSON, ARTHUR WILLIAM MAYO, Hunterian Professor of Surgery, Royal College of Surgeons; Consulting Surgeon, Leeds General Infirmary; Emeritus Professor of Surgery in the Yorkshire College; 8, Park crescent, London. *Trans.* 6. *Pro.* 1.

1890 ROLLESTON, HUMPHRY DAVY, M.D., Physician to, and Lecturer on Pathology at, St. George's Hospital; Senior Physician to Out-patients, Victoria Hospital for Children; 55, Upper Brook street, Grosvenor square.

Elected

1857 **Rose**, HENRY COOPER, M.D., 16, Warwick road, Maida Vale. C. 1886-7. *Trans.* 1.

1888 ROUGHTON, EDMUND WILKINSON, B.S., M.D., Surgeon and Surgical Tutor to the Royal Free Hospital; 38, Queen Anne street. *Trans.* 1.

1882 ROUTH, AMAND JULES MCCONNEL, M.D., B.S., Obstetric Physician to, and Lecturer on Midwifery at, the Charing Cross Hospital; Consulting Physician to the Samaritan Free Hospital for Women and Children; 14A, Manchester square. C. 1902-4. *Lib. Com.* 1900-2. *Referee*, 1900-2.

1849 **Routh**, CHARLES HENRY FELIX, M.D., Consulting Physician to the Samaritan Free Hospital for Women and Children; 52, Montagu square. *Lib. Com.* 1854-5. *Trans.* 1.

1891 RUSSELL, J. S. RISIEN, M.D., Assistant Physician to University College Hospital, and Pathologist to the National Hospital for the Paralysed and Epileptic, Queen square; 44, Wimpole street, Cavendish square. *Trans.* 1.

1900 RYALL, CHARLES, 51, Queen Anne street.

1903 RYAN, JOHN RUSSELL, B.A., M.D., B.Ch., B.A.O., 5, Bennett street, St. James's.

1886 SAINSBURY, HARRINGTON, M.D., Physician to the Royal Free Hospital; Physician to the City of London Hospital for Diseases of the Chest; 52, Wimpole street, Cavendish square. *Trans.* 1.

1902 SAMBON, LOUIS W., M.D., London School of Tropical Medicine, Greenwich.

1899 SANDILANDS, JOHN EDWARD, M.B., 9, Sussex villas, Kensington.

Elected

1903 SANDWITH, FLEMING MANT, M.D., 31, Cavendish square. (May—Dec.) Cairo (Jan.—April).

1869 **Sansom,** ARTHUR ERNEST, M.D., Physician to the London Hospital; Consulting Physician, North-Eastern Hospital for Children; 83, Harley street, Cavendish square. C. 1887-8. *Referee*, 1889—. *Trans.* 3.

1902 SAUNDERS, EDWARD ARTHUR, M.A., M.B., B.Ch., D.Ph., Assistant Physician and Physician to the Department for the Medical Diseases of Children, West London Hospital; 49, Harley street, Cavendish square.

1879 SAVAGE, GEORGE HENRY, M.D., Lecturer on Mental Diseases at Guy's Hospital; 3, Henrietta street, Cavendish square. C. 1898-9.

1892 SCHORSTEIN, GUSTAVE M.A., M.B., B.Ch., D.P.H., Assistant Physician to the London Hospital, and to the Hospital for Consumption, Brompton; 11, Portland place.

1899 SCOTT, LINDLEY MARCROFT, M.D., 98, Sloane street.

1863 **Sedgwick,** WILLIAM, 72, King Edward's gardens, Acton hill, Acton. C. 1884-5. *Trans.* 3.

1892 SEGUNDO, CHARLES SEMPILL DE, M.B., B.S., 6, Brook street, Hanover square.

1892 SELWYN-HARVEY, JOHN STEPHENSON, M.D., 1, Astwood road, Cromwell road.

1877 SEMON, SIR FELIX, C.V.O., M.D., Physician Extraordinary to H.M. the King; Physician for Diseases of the Throat to the National Hospital for Epilepsy and Paralysis, Queen square; 39, Wimpole street, Cavendish square. C. 1895-7. *Lib. Com.* 1894-5. *Trans.* 3.

1900 SEQUEIRA, JAMES HARRY, M.D., 63, Harley street.

1894 SEWILL, JOSEPH SEFTON, 9A, Cavendish square.

1882 SHARKEY, SEYMOUR JOHN, M.D., Physician to, and Joint Lecturer on Medicine at, St. Thomas's Hospital; 22, Harley street, Cavendish square. C. 1899-1900. *Referee*, 1897-9, 1902—. *Trans.* 2.

Elected

1900 SHAW, HAROLD BATTY, M.D., 7, Devonshire street, Portland place.

1886 SHAW, LAURISTON ELGIE, M.D., Physician to Guy's Hospital; 64, Harley street, Cavendish square. *Referee*, 1903—.

1884 SHEILD, ARTHUR MARMADUKE, M.B., B.C., Assistant Surgeon to St. George's Hospital; 4, Cavendish place. *Referee*, 1897—. *Trans.* 6.

1903 SHERREN, JAMES, 40, Devonshire street.

1896 SHORE, THOMAS WILLIAM, M.D., Heathfield, Alleyn park, Dulwich.

1886 SILCOCK, ARTHUR QUARRY, B.S., Surgeon to, and Lecturer on Surgery at, St. Mary's Hospital; Surgeon to the Royal London Ophthalmic Hospital; 52, Harley street, Cavendish square. *Lib. Com.* 1895—.

1899 SIMPSON, WILLIAM JOHN RITCHIE, M.D., 12, Gloucester place, Portman square.

1894 SLATER, CHARLES, M.B., 81, St. Ermin's mansions, Westminster.

1890 SMALE, MORTON, Surgeon Dentist to St. Mary's Hospital; 22A, Cavendish square.

1879 SMITH, E. NOBLE, Surgeon to the City Orthopædic Hospital; Surgeon to All Saints' Children's Hospital; Orthopædic Surgeon to the British Home for Incurables; 24, Queen Anne street, Cavendish square.

1881 SMITH, EUSTACE, M.D., Physician to H.M. the King of the Belgians; Physician to the East London Children's Hospital, and to the Victoria Park Hospital for Diseases of the Chest; 15, Queen Anne street, Cavendish square. C. 1899-1900.

1866 SMITH, HEYWOOD, M.A., M.D., 25, Welbeck street, Cavendish square.

Elected

1889 SMITH, ROBERT PERCY, M.D., B.S., Lecturer on Psychological Medicine, Charing Cross Hospital; 36, Queen Anne street.

1863 **Smith**, SIR THOMAS, Bart., K.C.V.O., Honorary Sergeant-Surgeon to H.M. the King; Consulting Surgeon to St. Bartholomew's Hospital; 5, Stratford place, Oxford street. *Marshall Hall Trustee*, 1877—1903. S. 1870-2. C. 1875-6. V.P. 1887-8. *Referee*, 1873-4, 1880-6. *Sci. Com.* 1867. *Trans.* 4.

1872 SMITH, THOMAS GILBART, M.D., Physician to the London Hospital; Physician to the Royal Hospital for Diseases of the Chest, City road; 68, Harley street, Cavendish square. C. 1890. *Trans.* 1.

1873 SMITH, W. JOHNSON, Surgeon to the Seamen's Hospital Society, Greenwich.

1874 *Smith*, WILLIAM ROBERT, M.D., D.Sc., F.R.S.Edin., Barrister-at-Law, Professor of Forensic Medicine, and Director of the Laboratories of State Medicine in King's College, London; 74, Great Russell street. *Trans.* 1.

1889 SPENCER, HERBERT R., M.D., B.S., Professor of Midwifery in University College; Obstetric Physician to University College Hospital; 104, Harley street. *Referee*, 1894—.

1887 SPENCER, WALTER GEORGE, M.B., M.S., Surgeon to, and Lecturer on Physiology at, the Westminster Hospital; 35, Brook street, Grosvenor square. *Trans.* 2. *Lib. Com.* 1904—.

1888 SPICER, ROBERT HENRY SCANES, M.D., Surgeon to the Department for Diseases of the Throat, St. Mary's Hospital; 28, Welbeck street, Cavendish square.

Elected

1890 SPICER, WILLIAM THOMAS HOLMES, M.B., Ophthalmic Surgeon to St. Bartholomew's Hospital; Surgeon to the Royal London Ophthalmic Hospital (City road, late Moorfields); Consulting Ophthalmic Surgeon to the Metropolitan Hospital; 5, Wimpole street, Cavendish square.

1875 SPITTA, EDMUND JOHNSON, Ivy House, 31, South Side, Clapham Common, Surrey. C. 1903—.

1903 SPRIGGS, EDMUND IVENS, M.D., 26, St. Thomas's street.

1885 SQUIRE, JOHN EDWARD, C.B., M.D., Physician to the Mount Vernon Hospital for Consumption; 5, Harley street, Cavendish square. *Trans.* 2.

1897 STAINER, EDWARD, M.A., M.B., 60, Wimpole street.

1896 STEPHENS, JOHN WILLIAM WATSON, M.B., B.C., 8, Fopstone road, Earl's Court.

1899 STEWART, PURVES, M.D., 7, Harley street. *Trans.* 1.

1856 **Stocker**, ALONZO HENRY, M.D., Peckham House, Peckham.

1884 STONHAM, CHARLES, C.M.G., Surgeon to, and Lecturer on Surgery and Teacher of Operative Surgery at, the Westminster Hospital; Surgeon to the Poplar Hospital for Accidents; 4, Harley street, Cavendish square. C. 1904—.

1896 SUTHERLAND, GEORGE ALEXANDER, M.D., Physician to Paddington Green Children's Hospital; Assistant Physician to the North-West London Hospital; 73, Wimpole street, Cavendish square.

1896 SWAN, CHARLES ROBERT JOHN ATKIN, M.B., B.Ch., 4, Devonport street, Hyde Park.

1890 SYERS, HENRY WALTER, M.D., 75, Wimpole street.

Elected

1886 SYMONDS, CHARTERS JAMES, M.S., M.D., Surgeon to, and Surgeon in charge of the Throat Department at, Guy's Hospital; 58, Portland place. *Referee*, 1904—.

1903 TALBOT, EUSTACE, M.B., 10, Great George street, Westminster.

1875 TAY, WAREN, Senior Surgeon to the London Hospital, to the Royal London Ophthalmic Hospital, and to the Hospital for Diseases of the Skin, Blackfriars; Consulting Surgeon to the North-Eastern Hospital for Children; 4, Finsbury square.

1873 TAYLOR, FREDERICK, M.D., Physician to, and Lecturer on Medicine at, Guy's Hospital; Consulting Physician to the Evelina Hospital for Sick Children; 20, Wimpole street, Cavendish square. *Trustee*, 1893-1903. S. 1889-93. C. 1894-6. *Sci. Com.* 1889-1902. *Referee*, 1887-8, 1899—. *Trans.* 3.

1893 TAYLOR, JAMES, M.D., Assistant Physician to the National Hospital for the Paralysed and Epileptic; Physician to the North-Eastern Hospital for Children, and to the National Orthopædic Hospital; 49, Welbeck street, Cavendish square. *Trans.* 1.

1890 TAYLOR, SEYMOUR, M.D., Assistant Physician, West London Hospital; 16, Seymour street, Portman square.

1900 THOMPSON, CHARLES HERBERT, M.D., 133, Harley street, Cavendish square.

1862 **Thompson**, EDMUND SYMES, M.D., Consulting Physician to the Hospital for Consumption, Brompton; Gresham Professor of Medicine; 33, Cavendish square. S. 1871-4. C. 1878-9. *Sci. Com.* 1889-1902. *Referee*, 1876-7. *Trans.* 1.

1904. THOMPSON, HENRY EDMUND SYMES, 33, Cavendish Square. *Trans.* 1.

1862 **Thompson**, REGINALD EDWARD, M.D., 13, Cheyne gardens, Chelsea. C. 1879. S. 1880-82. V.P. 1883-4. *Referee*, 1873-8. *Sci. Com.* 1867. *Trans.* 2.

Elected

1899 THOMSON, HERBERT CAMPBELL, M.D., Assistant Physician to the Middlesex Hospital and Physician to the Hospital for Epilepsy and Paralysis, Maida Vale; 34, Queen Anne street. *Trans.* 2.

1892 THOMSON, STCLAIR, M.D., Physician to the Throat Hospital, Golden Square; Surgeon to the Royal Ear Hospital, London; 28, Queen Anne street, Cavendish square. *Trans.* 1.

1892 THORNE, WILLIAM BEZLY, M.D., 53, Upper Brook street.

1899 THURSFIELD, JAMES HUGH, M.D., 45, Weymouth street, Portland place. *Trans.* 2.

1889 TIRARD, NESTOR ISIDORE CHARLES, M.D., Professor of the Principles and Practice of Medicine, King's College; Physician to King's College Hospital, and Physician to the Evelina Hospital for Sick Children; 74, Harley street, Cavendish square.

1872 TOMES, CHARLES SISSMORE, M.A., F.R.S., 9, Park crescent, Portland place. C. 1887. V.P. 1897-99. *Lib. Com.* 1879.

1882 TOOTH, HOWARD HENRY, C.M.G., M.D., Physician to the National Hospital for the Paralysed and Epileptic, Queen square; Assistant Physician to St. Bartholomew's Hospital; 34, Harley street, Cavendish square. *Referee*, 1902—. *Sci. Com.* 1896-1902.

1879 **Treves**, SIR FREDERICK, Bart., C.B., K.C.V.O., LL.D., Sergeant-Surgeon in Ordinary to H.M. the King; Surgeon in Ordinary to H.R.H. the Prince of Wales; Kt. of Grace of St. John; Consulting Surgeon to the London Hospital; 6, Wimpole street, Cavendish square. C. 1895-6. *Referee*, 1890-95. *Sci. Com.* 1889-95. *Trans.* 6.

Elected

1902 TREVOR, ROBERT SALUSBURY, M.B., B.C., 21, FitzGeorge avenue, West Kensington.

1859 **Truman**, EDWIN THOMAS, Surgeon-Dentist to His Majesty's Household; 23, Old Burlington street.

1897 TUNNICLIFFE, FRANCIS WHITTAKER, M.D., 129, Harley street.

1889 TURNBULL, GEORGE LINDSAY, M.D., 47, Ladbroke square.

1882 TURNER, GEORGE ROBERTSON, Surgeon to, and Joint Lecturer on Surgery at, St. George's Hospital; 41, Half Moon street, Piccadilly. C. 1903—4. *Trans.* 1.

1898 TURNER, WILLIAM, M.B., B.S., Assistant Surgeon, Westminster Hospital; 53, Queen Anne street, Cavendish square.

1896 TURNER, WILLIAM ALDREN, M.D., Assistant Physician to King's College Hospital and to the National Hospital for the Paralysed and Epileptic, Queen Square; 18, Harley street. *Trans.* 2.

1896 TURNEY, HORACE GEORGE, M.D., Joint Lecturer on Pathology and Assistant Physician to St. Thomas's Hospital; 68, Portland place. *Trans.* 1.

1892 TWEEDY, JOHN, Professor of Ophthalmic Medicine and Surgery in University College, Ophthalmic Surgeon to University College Hospital, and Surgeon to the Royal London Ophthalmic Hospital; 100, Harley street, Cavendish square.

1876 VENN, ALBERT JOHN, M.D., 63, Grosvenor street.

1870 VENNING, EDGCOMBE, 30, Cadogan place. C. 1898-1900 V.P. 1902—4. *Ho. Com.* 1903—4.

1902 VINCENT, RALPH, M.D., B.S., 1, Harley street.

Elected

1891 VOELCKER, ARTHUR FRANCIS, M.D., B.S., Assistant Physician to, and Lecturer on Pathology at, the Middlesex Hospital; Assistant Physician, Hospital for Sick Children, Great Ormond street; 101, Harley street.

1896 WAGGETT, ERNEST, M.B., B.C., Surgeon, London Throat Hospital; Surgeon to Out Patient Throat and Ear Department, Great Northern Central Hospital; 45, Upper Brook street.

1884 WAKLEY, THOMAS, jun., 16, Hyde Park Gate.

1896 WALDO, FREDERICK JOSEPH, M.D., City Coroner, 40, Lansdowne road, Holland park.

1900 WALKER, H. ROE, 8, Harley street, Cavendish square.

1900 WALKER, JOHN WILLIAM THOMSON, M.B., Assistant Surgeon to the North-West London Hospital, and to St. Peter's Hospital; 8, Cavendish place. *Trans.* 1.

1883 WALLER, AUGUSTUS, M.D., F.R.S., Lecturer on Physiology, St. Mary's Hospital; Weston Lodge, 32, Grove End road, St. John's Wood. *Referee* 1895—.

1888 WALLIS, FREDERICK CHARLES, M.B., B.C., Assistant Surgeon to the Charing Cross Hospital; 107, Harley street, Cavendish square.

1896 WALSHAM, HUGH, M.A., M.D., Assistant Physician to the City of London Hospital for Diseases of the Chest; Assistant Medical Officer in Electrical Department, St. Bartholomew's Hospital; 114, Harley street, Cavendish square.

1886 WARD, ALLAN OGIER, M.D., 73, Cheapside.

1894 WARD-HUMPHREYS, GEORGE HERBERT, 26, Charles street, St. James's.

Elected

1891 WARING, H. J., M.B., M.S., B.Sc., Assistant Surgeon and Demonstrator of Operative Surgery, St. Bartholomew's Hospital; Surgeon, Metropolitan Hospital; 37, Wimpole street.

1877 **Warner,** FRANCIS, M.D., Physician to, and Lecturer on Materia Medica and Therapeutics at, the London Hospital; 5, Prince of Wales terrace, Kensington Palace. C. 1899-1901. *Trans.* 3.

1894 WATERHOUSE, HERBERT FURNIVALL, C.M., Senior Assistant Surgeon and Lecturer on Anatomy, Charing Cross Hospital; Surgeon, Victoria Hospital for Children; 81, Wimpole street.

1903 WATSON, CHARLES GORDON, 44, Welbeck street, Cavendish square.

1861 **Watson,** WILLIAM SPENCER, M.B., 44, Chepstow place, Kensington. C. 1883-4. *Trans.* 1.

1891 **Weber,** FREDERIC PARKES, M.D., Physician to the German Hospital, Dalston; 19, Harley street. *Trans.* 2. *Pro.* 1.

1857 WEBER, SIR HERMANN, M.D., Consulting Physician to the German Hospital; 10, Grosvenor street, Grosvenor square. C. 1874-5. V.P. 1885-6. *Sci. Com.* 1889-1902. *Referee,* 1869-73, 1878-84. *Lib. Com.* 1864-73. *Trans.* 6.

1895 WELLS, SYDNEY RUSSELL, M.D., 24, Somerset street, Portman square.

1903 WEST, CHARLES ERNEST, 10, Norland square.

1877 WEST, SAMUEL, M.D., Assistant Physician to St. Bartholomew's Hospital; Senior Physician to the Royal Free Hospital; 15, Wimpole street, Cavendish square. C. 1894-5. *Lib. Com.* 1892-4. *Trans.* 7.

Elected

1888 WETHERED, FRANK JOSEPH, M.D., Assistant Physician to the Hospital for Consumption, Brompton; 83, Harley street, Cavendish square. *Trans.* 1.

1881 WHARRY, ROBERT, M.D., 7, Cambridge gate, Regent's park.

1891 WHITE, CHARLES PERCIVAL, M.B., B.C., 22, Cadogan gardens.

1897 WHITE, CHARLES POWELL, Pathological Department, St. Thomas's Hospital.

1881 WHITE, WILLIAM HALE, M.D., Physician to, and Lecturer on Materia Medica at, Guy's Hospital; 65, Harley street, Cavendish square. C. 1900-2. *Referee*, 1888-97, 1899-1900. *Trans.* 4.

1890 WHITE-COOPER, W. G. O., M.B., 5, Courtfield road, Gloucester road.

1897 WHITFIELD, ARTHUR, M.D., 21, Bentinck street, Manchester square. *Trans.* 1.

1899 WHITING, ARTHUR J., M.D., 142, Harley street.

1902 WIGHTWICK, FALLON PERCY, M.D., 9A, Upper Brook street.

1863 **Wilks**, SIR SAMUEL, Bart., M.D., LL.D., F.R.S., Physician Extraordinary to Her late Majesty Queen Victoria, Physician in Ordinary to their Royal Highnesses the Duke and Duchess of Connaught; Consulting Physician to Guy's Hospital; 8, Prince Arthur road, Hampstead. *Referee*, 1872–81.

1890 WILLCOCKS, FREDERICK, M.D., Physician to Out-Patients, and Lecturer on Materia Medica and Therapeutics, at the Charing Cross Hospital; Physician to the Evelina Hospital for Sick Children; 14, Mandeville place, Manchester square.

Elected

1865 **Willett**, ALFRED, Surgeon to St. Bartholomew's Hospital; Surgeon to St. Luke's Hospital; 36, Wimpole street, Cavendish square. *Trustee*, 1892—1903. C. 1880-1. V.P. 1890-1. P. 1902—4. *Referee*, 1882-9, 1892-1902. *Bldg. Com.* 1889-92. *Ho. Com.* 1892-8. *Cent. Com.* 1904—. *Trans.* 2.

1887 WILLETT, EDGAR, M.B., 22, Queen Anne street, Cavendish square.

1902 **Willett**, JOHN ABERNETHY, M.B., 36, Wimpole street, Cavendish square.

1888 WILLIAMS, CAMPBELL, 18, Queen Anne street.

1866 **Williams**, CHARLES THEODORE, M.A., M.D., *Trustee for Debenture-holders;* Consulting Physician to the Hospital for Consumption and Diseases of the Chest, Brompton; 2, Upper Brook street, Grosvenor square. C. 1884-5. V.P. 1900-2. *Referee*, 1888-1900. *Lib. Com.* 1880-3. *Ho. Com.* 1900-2. *Sci. Com.* 1889-1902. *Trans.* 6.

1881 WILLIAMS, DAWSON, M.D., Physician to the East London Hospital for Children; 2, Agar street, Strand *Trans.* 1.

1901 WILLIAMS, LEONARD, M.D., 8, York street, Portman square.

1903 WILLIAMSON, OLIVER K., M.A., M.D., 50, Upper Berkeley street.

1890 WILLS, WILLIAM ALFRED, M.D., Assistant Physician to the Westminster Hospital; Senior Physician to the North-Eastern Hospital for Children; 29, Lower Seymour street, Portman square. *Trans.* 1.

1879 WOAKES, EDWARD, M.D., Senior Aural Surgeon to the London Hospital; 78, Harley street, Cavendish square.

Elected

1887 WOOD, THOMAS OUTTERSON, M.D., Senior Physician to the West End Hospital for Nervous Diseases; 40, Margaret street, Cavendish square.

1892 WRIGHT, ALMROTH EDWARD, M.D., Ch.B., 7, Lower Seymour street. *Trans.* 1.

1890 WYNTER, WALTER ESSEX, M.D., Physician to the Middlesex Hospital; 27, Wimpole street.

LIST OF RESIDENT FELLOWS

ARRANGED ACCORDING TO

DATE OF ELECTION

1848 John Clarke, M.D.
1849 C. H. F. Routh, M.D.
1851 John A. Kingdon.
1854 Sir Alfred B. Garrod, M.D., F.R.S.
1856 Jonathan Hutchinson, F.R.S.
Timothy Holmes.
Alonzo H. Stocker, M.D.
1857 Sir Hermann Weber, M.D.
Henry Cooper Rose, M.D.
Henry Walter Kialmark.
1858 John William Ogle, M.D.
1859 Wm. Howship Dickinson, M.D.
Edwin Thomas Truman.
Richard Barwell.
1860 William Ogle, M.D.
Thomas Bryant.
John Couper.
1861 William Spencer Watson.
1862 Lionel Smith Beale, M.B., F.R.S.
Edmund Symes Thompson, M.D.
Reginald Edward Thompson, M.D.
George Cowell.
1863 Sir Samuel Wilks, Bt., M.D., F.R.S.
Sydney Ringer, M.D., F.R.S.
Sir Thomas Smith, Bart., K.C.V.O.
Arthur B. R. Myers.
William Sedgwick.
1864 Thomas William Nunn.
1865 James Edward Pollock, M.D.
George Fielding Blandford, M.D.
Sir Dyce Duckworth, M.D.
Frederick W. Pavy, M.D., F.R.S.
John Langton.
Frederick James Gant.
Alfred Willett.
Sir Alfred Cooper.
Christopher Heath.
1866 Samuel Jones Gee, M.D.
Charles Theodore Williams, M.D.
Heywood Smith, M.D.
Sir William Selby Church, Bart., K.C.B., M.D.
1867 Sir R. Douglas Powell, Bart., M.D.
F. Howard Marsh.
Henry Power.
1868 H. Charlton Bastian, M.D., F.R.S.
Sir W. H. Broadbent, Bart., M.D., K.C.V.O., F.R.S.
Thomas Buzzard, M.D.
Walter Butler Cheadle, M.D.
T. Henry Green, M.D.
George Eastes, M.B.
1869 Joseph Frank Payne, M.D.
Arthur E. Sansom, M.D.
Thomas Laurence Read.
1870 J. Warrington Haward.

1870 Edgcombe Venning.
Clement Godson, M.D.
Reginald Harrison.
Robert Leamon Bowles, M.D.
1871 William Cayley, M.D.
Sir T. Lauder Brunton, M.D., F.R.S.
J. Hughlings Jackson, M.D., F.R.S.
Philip Frank, M.D.
1872 T. Gilbart-Smith, M.D.
Sir J. Fayrer, M.D., F.R.S.
Charles S. Tomes, M.A., F.R.S.
Sir William Bartlett Dalby.
1873 Frederick Taylor, M.D.
Norman Moore, M.D.
Sir William R. Gowers, M.D., F.R.S.
Jeremiah McCarthy.
Wm. Johnson Smith.
Henry T. Butlin.
1874 Alfred Lewis Galabin, M.D.
John Mitchell Bruce, M.D.
Henry Morris, M.A.
William Laidlaw Purves.
William Harrison Cripps.
Sir Henry G. Howse, M.S.
Herbert William Page.
Frederic Durham.
William Robert Smith, M.D.
1875 Thomas Crawford Hayes, M.D.
Waren Tay.
Edmund J. Spitta.
Fletcher Beach, M.B.
1876 Sir Thomas Barlow, Bart., K.C.V.O., M.D.
Albert J. Venn, M.D.
1877 Sir Felix Semon, C.V.O., M.D.
Sidney Coupland, M.D.
Francis Warner, M.D.
William Ewart, M.D.
Alfred Pearce Gould, M.S.
Rickman J. Godlee, M.S.
Alban H. G. Doran.
George Ernest Herman, M.B.
Samuel West, M.D.
John Abercrombie, M.D.
George Allan Heron, M.D.
Joseph A. Ormerod, M.D.
P. Henry Pye-Smith, M.D., F.R.S.
Sir William Henry Bennett, K.C.V.O.
1878 Sir Jas. Crichton-Browne, M.D.
Fred. T. Roberts, M.D.
Lord Lister, P.C., O.M., F.R.S.
Clinton T. Dent.
John H. Morgan, C.V.O.
Donald W. Charles Hood, C.V.O., M.D.
1879 Edward Woakes, M.D.
Malcolm A. Morris.
A. E. Cumberbatch.
Edmund Owen.
Arthur E. J. Barker.
Sir Fredk. Treves, Bart., C.B., K.C.V.O.
Andrew Clark.
Francis Henry Champneys, M.D.
William Watson Cheyne, C.B., F.R.S.
George Henry Savage, M.D.
H. H. Clutton, M.A.
Frederic S. Eve.
E. Noble Smith.
William Henry Allchin, M.D.
1880 Robert Alex. Gibbons, M.D.
David Ferrier, M.D., F.R.S.
Edmund Distin Maddick.
Jas. John MacWhirter Dunbar, M.D.
James William Browne, M.B.
William Appleton Meredith, M.B.
Malcolm Macdonald McHardy.
A. Boyce Barrow.
William Murrell, M.D.
George Ogilvie, M.B.
Charles Edward Beevor, M.D.
Thomas Colcott Fox, M.B.
George Henry Makins, C.B.
1881 Francis de Havilland Hall, M.D.
Robert Wharry, M.D.
Richard Clement Lucas, B.S.
Sir Stephen Mackenzie, M.D.
William Hale White, M.D.
Eustace Smith, M.D.
Percy Kidd, M.D.
Oswald A. Browne, M.D.
W. Bruce Clarke, M.B.
Dawson Williams, M.D.
George Lindsay Johnson, M.D.
Henry Edward Juler.
Jonathan F. C. H. Macready.
C. B. Lockwood.
1882 Philip J. Hensley, M.D.
Ernest Clarke, M.D., B.S.
George Robertson Turner.
Howard Henry Tooth, C.M.G., M.D.
Sir Herbert Isambard Owen, M.D.
Charles R. B. Keetley.

1882 Anthony A. Bowlby, C.M.G.
Amand J. McC. Routh, M.D.
Seymour J. Sharkey, M.D.
William Lang.
Henry Radcliffe Crocker, M.D.
Sir James Reid, Bart., G.C.V.O.
1883 Edwin Clifford Beale, M.A., M.B.
James Kingston Fowler, M.D.
James Frederic Goodhart, M.D.
Walter H. Jessop, M.B.
Walter Edmunds, M.C.
Sir Victor A. Horsley, F.R.S.
Dudley Wilmot Buxton, M.D.
Charles Douglas F. Phillips, M.D.
John James Pringle, M.B.
Wilmot Parker Herringham, M.D.
Augustus Waller, M.D.
William Pasteur, M.D.
John Bland-Sutton.
Robert Marcus Gunn, M.B.
1884 George Newton Pitt, M.D.
Charles Stonham, C.M.G.
Stanley Boyd, B.S.
William Arbuthnot Lane, M.S.
Arthur Marmaduke Sheild, M.B.
Sidney Harris Cox Martin, M.D., F.R.S.
Thomas Wakley, jun.
F. Swinford Edwards.
James Johnston, M.D.
William Duncan, M.D.
George Richard Turner Phillips.
Bilton Pollard.
1885 Alexander Haig, M.D.
Theodore Dyke Acland, M.D.
Frederick Walker Mott, M.D., F.R.S.
James Berry.
John Cahill, M.D.
John Poland.
A. C. Butler-Smythe.
Charles Alfred Ballance, M.S.
Walter S. A. Griffith, M.D.
John Edward Squire, C.B., M.D.
John D. Malcolm, M.B., C.M.
Phineas S. Abraham, M.D.
1886 Robert Maguire, M.D.
Harrington Sainsbury, M.D.
Cuthbert Hilton Golding-Bird, M.B.
Lauriston Elgie Shaw, M.D.
Charters James Symonds, M.S.
Robert Boxall, M.D.
Allan Ogier Ward, M.D.
1886 Archibald Edward Garrod, M.D.
Stephen Paget.
William Radford Dakin, M.D.
Samuel Herbert Habershon, M.D.
Arthur Quarry Silcock.
Arthur H. N. Lewers, M.D.
1887 Walter George Spencer.
Thomas Outterson Wood, M.D.
Edgar William Willett, M.B.
Henry Lewis Jones, M.D.
Francis George Penrose, M.D.
Hugh Percy Dunn.
Frederic William Hewitt, M.V.O., M.D.
James Barry Ball, M.D.
Gilbert Richardson, M.D.
D'Arcy Power, M.B.
John Gay.
James Calvert, M.D.
Percy J. F. Lush, M.B.
Edward James Wallace, M.D.
1888 Robert Henry Scanes Spicer, M.D.
Jonathan Hutchinson, jun.
Campbell Williams.
James Donelan, M.B., C.M.
John Anderson, M.D., C.I.E.
Laurie Asher Lawrence.
Arthur Pearson Luff, M.D., B.Sc.
Albert Carless, M.S.
Frederick C. Wallis, M.B., B.C.
Charles James Cullingworth, M.D.
Edmund Cautley, M.D., B.C.
H. Montague Murray, M.D.
Frank Joseph Wethered, M.D.
Edmund Wilkinson Roughton, B.S.
Frederick William Cock, M.D.
Robert Henry Clarke, M.B.
1889 Montagu Handfield-Jones, M.D.
David Henry Goodsall.
Raymond Johnson, M.B.
John Fletcher Little, M.B.
Henry Work Dodd.
George Lindsay Turnbull, M.D.
Sidney Phillips, M.D.
Henry Percy Dean, M.B., M.S.
William Hunter, M.D.
J. Inglis Parsons, M.D.
Bernard Pitts, M.B., M.C.
Robert Percy Smith, M.D., B.S.
Herbert R. Spencer, M.D., B.S.
Nestor Isidore Chas. Tirard, M.D.
Arthur William Mayo Robson.
Harold Jossé Johnson.
1890 John Rose Bradford, M.D., F.R.S.

1890 Charles D. B. Hale, M.D.
Sir Edwin Cooper Perry, M.D.
Morton Smale.
Frederick Willcocks, M.D.
William T. Holmes Spicer, M.B.
Thomas Henry Crowle.
Henry Walter Syers, M.D.
Seymour Taylor, M.D.
William Alfred Wills, M.D.
G. O. White-Cooper, M.B.
Herbert William Allingham.
William A. F. Bateman.
James Jackson Clarke, M.B.
Leonard G. Guthrie, M.D., B.Ch.
G. William Hill, M.D., B.Sc.
Edward Law, M.D., C.M.
Sir Patrick Manson, K.C.M.G., M.D., C.M., F.R.S.
Humphry D. Rolleston, M.D.
Walter Essex Wynter, M.D., B.S.
Edward Lawrie, M.B.
Christopher Childs, M.D.

1891 William Lee Dickinson, M.D.
Herbert P. Hawkins, M.D., B.Ch.
Cyril Ogle, M.A., M.B.
Arthur F. Voelcker, M.D., B.S.
Herbert T. Herring, M.B., B.S.
Ernest Muirhead Little.
Henry Charrington Martin, M.D.
Frederick William Andrewes, M.D.
Alfred Eddowes, M.D.
Herbert Morley Fletcher, M.D.
William Heaton Hamer, M.D.
John Arthur Hayward, M.D.
William Bromfield Paterson.
Holburt Jacob Waring.
Frederic Parkes Weber, M.D.
F. E. Batten, M.D.
Thomas Jessopp Bokenham.
Norman Dalton, M.D.
P. R. W. De Santi.
P. W. Dove.
William J. Gow, M.D.
Paul Frank Moline, M.B.
Edward Percy Paton, M.D.
Arthur Bowen Rendel, M.B., B.C.
James Samuel Risien Russell, M.D.
Charles Percival White, M.B., B.C.
W. Page May, M.D.
Richard J. Reece.
Charles Ernest Baker, M.B.

1892 J. Dundas Grant, M.D.
R. J. Bliss Howard, M.D.
Thomas Horrocks Openshaw, C.M.G., M.B.
William Bezly Thorne, M.D.
W. H. Russell Forsbrook, M.D.
John Harold, M.B.
John Alfred Masters, M.D.
Gustave Schorstein, M.B.
Charles Sempill de Segundo, M.B.
John Tweedy.
J. S. Selwyn-Harvey, M.D.
StClair Thomson, M.D.
Henry Rayner, M.D.
H. Marmaduke Page.
Almroth Edward Wright, M.D.

1893 James Taylor, M.D.
Howard Barrett.
Robert Cozens Bailey, M.B.
Henry Albert Caley, M.D.
Arthur Edward Giles, M.D.
Miles Miley, M.B.
D. Watkin Roberts, M.D.
Leonard A. Bidwell.
Frédéric F. Burghard, M.D., M.S.
J. H. Drysdale, M.B.
William McAdam Eccles, M.S.
Vaughan Harley, M.D.
George Herschell, M.D.
Arnold Lawson.
Guthrie Rankin, M.D.

1894 Richard Gill.
Joseph Sefton Sewill.
Thomas Vincent Dickinson, M.D.
Alexander Morison, M.D.
L. Hemington Pegler, M.D.
Herbt. Furnivall Waterhouse, C.M.
Percy Furnivall.
R. L. Langdon-Down, M.B., B.C.
Allan Macfadyen, M.D., B.S.
Ernst Michels, M.D.
Wm. Rivers Pollock, M.B., B.C.
Charles Slater, M.B.
G. H. Ward-Humphreys.

1895 Charles Arthur Parker.
Sydney Russell Wells, M.D.
Alfred Milne Gossage, M.B.
Robert Murray Leslie, M.B.
James Galloway, M.D.
David Bridge Lees, M.D.
Arthur G. Phear, M.D.
Edward Erskine Henderson, M.B.

1896 Joseph Lockhart Downes, M.B.
Edward Wilberforce Goodall, M.D.
James Ernest Lane.
George Alex. Sutherland, M.D.

1896 Charles Buttar, M.D.
P. J. Freyer, M.D., I.M.S., M.A.
Percival Horton-Smith, M.D.
James Keogh Murphy, M.B.
Thomas William Shore, M.D.
William Aldren Turner, M.D.
Charles Hubert Roberts, M.D.
Charles R. J. Atkin Swan, M.B.
James Kingston Barton.
J. Walter Carr, M.D.
John H. Dauber, M.A., M.B., B.Ch.
Alexander Grant Russell Foulerton.
L. Vernon Jones, B.A., M.D., B.Ch.
Henry Betham Robinson, M.S.
Horace George Turney, M.D.
Ernest Waggett, M.B., B.C.
Frederick Joseph Waldo, M.D.
Hugh Walsham, M.D.
J. W. W. Stephens, M.D.
William Edward Lee, M.D.

1897 Comyns Berkeley, M.B., B.C.
William Arthur Brailey, M.D.
James Cantlie, M.B.
Raymond H. Payne Crawfurd, M.D.
Francis Whittaker Tunnicliffe, M.D.
Arthur Whitfield, M.D.
Edward Stainer, M.A., M.B.
Alfred G. Levy, M.D.
A. P. Beddard, M.B.
G. F. Blacker, M.D.
W. S. Colman, M.D.
F. W. Goodbody, M.D.
R. Hutchison, M.D.
Harold Low.
Christopher Addison, M.D.
Charles Powell White.

1898 J. H. Bryant, M.D.
L. A. Dunn, M.S.
E. Hurry Fenwick.
Sir A. Downing Fripp, C.B., M.V.O., M.S.
A. Corrie Keep, M.D.
A. C. Latham, M.D.
J. B. Lawford.
John McFadyean.
H. Murray Ramsay.
J. F. H. Broadbent, M.D.
A. Stark Currie, M.D.
James Morrison, M.D.
Thomas J. Horder, M.D.
F. W. Robertson.
S. Jervois Aarons, M.D.
Willmott Evans, M.D., B.S., B.Sc.

1898 John Murray.
W. Adams Frost.
C. R. C. Lyster.
Samuel Noble Bruce.
Cuthbert Chapman Gibbes, M.D.
H. Stringfellow Pendlebury, M.B.
William Turner, M.B.
Alexander Crombie, C.B., M.D.
Thomas Herbert Kellock, M.D.

1899 James Hugh Thursfield, M.D.
Lindley Marcroft Scott, M.D.
Alfred P. Hillier, M.D.
Louis Bathe Rawling, M.B.
John Edward Sandilands, M.B.
Arthur J. Whiting, M.D.
Edward Farquhar Buzzard, M.D.
Greville Macdonald, M.D.
George Jones, M.B.
Herbert Campbell Thomson, M.D.
Thomas Morison Legge, M.D.
William John Ritchie Simpson, M.D.
Karl Fürth, M.D.
Purves Stewart, M.D.

1900 Clive Riviere, M.D.
H. Roe Walker.
Richard Lake.
Percy Flemming, M.D., B.S.
John Shields Fairbairn, M.B., B.Ch.
Aslett Baldwin.
Charles Ryall.
William Hern.
Cecil Huntington Leaf, M.B.
Lieut.-Col. William Reid Murphy, D.S.O., I.M.S.
James Harry Sequeira, M.D.
Harold Batty Shaw, M.D.
Charles Herbert Thompson, M.D.
John William Thomson Walker.

1901 Sir Hugh Reeve Beevor, Bart., M.D.
J. Brunton Blaikie, M.D.
John Patrick Henry, M.D.
Herbert John Paterson.
George Henkell Drummond Robinson, M.D.
Elmore Wright Brewerton.
Thomas Rupert Hampden Bucknall, M.S., M.D.
William Douglas Harmer.
Henry George Plimmer.
Lionel Vernon Cargill.
T. N. Kelynack, M.D.

1901 Leonard Williams, M.D.
1902 J. P. Lockhart Mummery, B.A.
James Stansfield Collier, M.D., B.Sc.
Robert Salusbury Trevor, M.B., B.C.
Edward Arthur Saunders, M.B., B.Ch.
Ralph Vincent, M.D., B.C.
Herbert French, M.D.
Holland John Cotton, M.D., C.M.
Arthur Evans, M.S.
James Kerr, M.D., D.P.H.
Donald John Armour, M.B.
David Barty King, M.D., Ch.B.
Hector William Gavin Mackenzie, M.D.
John Abernethy Willett, M.B.
Thomas Crisp English.
Louis W. Sambon, M.D.
Joseph Blumfield, M.D., B.C.
Ernest Beddoe Hulbert, M.D.
Harold L. Barnard, M.S.
Fallon Percy Wightwick, M.D.
1903 Edmund Ivens Spriggs, M.D.
Otto F. F. Grünbaum, M.B., B.C.
1903 Samuel William Carruthers, M.D.
John Russell Ryan, M.D., B.Ch.
Oliver K. Williamson, M.D.
Herbert Louis Powell Hulbert.
William Lawrence Ascherson, M.B., B.C.
Eustace Talbot, M.B.
Harold Burrows, M.B., B.S.
Leonard Dudgeon.
Evelyn Arthur Rich.
Fleming Mant Sandwith, M.D.
Charles Gordon Watson.
Charles Ernest West.
1904 Harold Shuttleworth Barwell, M.B.
Charles Bolton, M.D.
S. Vere Pearson, M.B.
James Sherren.
William Philip Sutcliffe Branson, M.B.
John Howell Evans.
Thomas Matheson Ness, M.B., C.M.
Henry Edmund Symes-Thompson, M.D.

The following Non-resident Fellows pay an annual subscription of £3 3s., and are thereby entitled to all the privileges of Resident Fellows.

Elected

1900 BLAKE, WILLIAM HENRY, M.D.Brux., Bedford Lodge, West Wickham, Kent.

1884 DRAGE, LOVELL, M.D., B.Ch.Oxon., Burleigh Mead, Hatfield, Herts.

EDKINS, J. S., Brambles, Watford road, Northwood.

1897 GILFORD, HASTINGS, Norwood House, King's road, Reading. *Trans.* 1.

1883 JACOBSON, WALTER HAMILTON ACLAND, M.Ch.Oxon. Surgeon to Guy's Hospital; Lordine Court, Ewhurst, Hawkhurst. C. 1902-3. *Referee*, 1895-1902. *Lib. Com.* 1896-1902. *Trans.* 2.

1900 PRICE-JONES, CECIL, M.B., 7, Claremont road, Surbiton, Surrey.

1882 REID, THOMAS WHITEHEAD, M.D., Surgeon to the Kent and Canterbury Hospital; St. George's House, Canterbury.

1891 RUFFER, MARC ARMAND, M.D., The Quarantine Board, Alexandria.

1898 THOMAS, J. LYNN, C.B., Surgeon to the Cardiff Infirmary; Consulting Surgeon to the Hamadryad Hospital, Green-lawn, Pen-y-Lan, Cardiff.

NON-RESIDENT FELLOWS

Elected

1866 *Allbutt, Thomas Clifford*, M.D., LL.D.Glasgow, F.R.S., Regius Professor of Physic, University of Cambridge; Consulting Physician to the Leeds General Infirmary; St. Rhadegund's, Cambridge. *Trans.* 4.

1903 *Amsden, Walter*, Chalford, Gloucestershire.

1884 *Anderson, Alexander Richard*, Surgeon to the General Hospital, 5, East Circus Street, Nottingham. *Trans.* 1.

1880 *Appleton, Henry*, M.D. (Address uncommunicated.)

1896 *Bagshawe, Frederic*, M.D., J.P., 35, Warrior Square, St. Leonard's-on-Sea.

1902 *Bailey, William Henry*, M.B., Featherstone Hall, Southall, Middlesex.

1891 *Balgarnie, Wilfred*, M.B., The Dutch House, Hartley Wintney, Winchfield.

1896 *Ball, Sir Charles Bent*, M.D., Ch.M., 24, Merrion square North, Dublin.

1866 *Banks, Sir John*, K.C.B., M.D., LL.D., D.Sc., Physician in Ordinary to H.M. the King in Ireland; Physician to Richmond, Whitworth, and Hardwicke Hospitals; Regius Professor of Physic in the University of Dublin; 45, Merrion square, Dublin.

1886 *Banks, Sir William Mitchell*, M.D., Surgeon to the Liverpool Royal Infirmary; 28, Rodney street, Liverpool.

Elected

1900 *Bardswell, Noel Dean*, M.D., The Sanatorium, Mundesley, Norfolk. *Trans.* 1.

1882 *Barker, Frederick Charles*, M.D., Surgeon-Major, Bombay Medical Service.

1881 *Barnes, Henry*, M.D., LL.D., F.R.S. Ed., Physician to the Cumberland Infirmary; 6, Portland square, Carlisle.

1861 **Barnes**, *Robert*, M.D., Bernersmede, Eastbourne. C. 1877-8. V.P. 1889-90. *Referee*, 1867-76, 1891—6. *Lib. Com.* 1869-73. *Sci. Com.* 1889—1902. *Trans.* 4.

1860 *Bealey, Adam*, M.D., M.A., Felsham Lodge, Felsham road, St. Leonard's-on-Sea, Sussex.

1896 *Belben, Frank*, M.A., M.B., Redlands, Knyveton road, Bournemouth.

1880 *Bennett, Alexander Hughes*, M.D. (Travelling.)

1889 *Bentley, Arthur J. M.*, M.D., Mena House, Pyramids, Cairo, Egypt.

1872 *Beverley, Michael*, M.D., Consulting Surgeon to the Norfolk and Norwich Hospital; 54, Prince of Wales road, Norwich.

1865 *Bickersteth, Edward Robert*, Consulting Surgeon to the Liverpool Royal Infirmary; 2, Rodney street, Liverpool. *Trans.* 1.

1892 *Bickersteth, Robert Alexander*, M.A., M.B., Assistant Surgeon to the Liverpool Royal Infirmary: 2, Rodney street, Liverpool.

1901 *Bisshopp, Francis R. B.*, M.D., Parham House, Tunbridge Wells.

1900 *Blake, William Henry*, M.D.Brux., Bedford Lodge, West Wickham, Kent.

1865 *Blanchet, Hilarion*, 35, Conillard street, Quebec, Canada.

1890 *Bostock, R. Ashton*, Surgeon, Scots Guards, Cefn Mor, Penmaen, Glamorganshire.

1869 *Bourne, Walter*, M.D. (Travelling.)

Elected

1874 *Bradshaw, A. F.*, C.B., Surgeon Major-General, 111, Banbury road, Oxford.

1899 *Bradshaw, Thomas Robert*, M.D., 51, Rodney street, Liverpool. *Trans.* 2.

1900 *Braine-Hartnell, James Christopher Reginald*, Oriel Lodge, Cheltenham.

1899 *Bremridge, Richard Harding*, Mysore, India (c/o R. Bremridge, 17, Bloomsbury square).

1876 *Bridges, Robert*, M.B., Manor House, Yattendon, Newbury, Berks.

1867 *Bridgewater, Thomas*, M.B., LL.D., Harrow-on-the-Hill, Middlesex.

1891 *Brodie, Charles Gordon*, Fernhill, Wootton Bridge, Isle of Wight.

1892 *Bronner, Adolph*, M.D., Senior Surgeon to Bradford Eye and Ear Hospital; Laryngologist to Bradford Royal Infirmary; 33, Manor row, Bradford.

1894 *Brook, William Henry Breffit*, M.D., B.S., 8, Eastgate, Lincoln.

1899 *Brooksbank, Hugh Lamplugh*, M.B., B.C., 5, College road, Windermere.

1888 *Browne, Henry Langley*, Moor House, West Bromwich.

1881 *Browne, John Walton*, M.D., Surgeon to the Belfast Royal Hospital; Surgeon to the Belfast Ophthalmic Hospital; 10, College square N., Belfast.

1864 *Buckle, Fleetwood*, M.D., Merton Lodge, Merton road, Southsea.

1904 *Butcher, William Deane*, Holywood, Cleveland road, Ealing.

1901 *Byrne, William Samuel*, M.D., Anne street, Brisbane, Queensland.

1891 *Campbell, Henry Johnstone*, M.D., 36, Manningham lane, Bradford.

1900 *Carlyon, Thomas Baxter*, 6, Marine place, Dover.

1888 *Carter, William Jeffreys Becher*, Aliwal North, Cape Colony.

Elected

1898 *Cave, Edward John*, M.D., Bath.

1884 *Chaffey, Wayland Charles*, M.D., Physician to the Royal Alexandra Hospital for Children; 13, Montpellier road, Brighton.

1885 *Chapman, Paul Morgan*, M.D., Physician to the Hereford General Infirmary, 1, St. John street, Hereford. *Trans.* 1.

1881 *Chavasse, Thomas Frederick*, M.D., C.M., Senior Surgeon to the Birmingham General Hospital; 22, Temple row, Birmingham. *Trans.* 3.

1873 *Chisholm, Edwin*, M.D., 44, Rosslyn gardens, Darlinghurst, Sydney, New South Wales.

1896 *Christopherson, John Brian*, M.D., B.C., late Assistant Demonstrator of Anatomy at St. Bartholomew's Hospital; late Surgeon to Seamen's Hospital, Albert Dock; c/o P.M.O., Egyptian Army, Cairo.

1892 *Clark, James Charles*, 35, Castle road, Bedford.

1897 *Clark, W. Gladstone*, Civil Service Club, Capetown.

1857 *Coates, Charles*, M.D., Consulting Physician to the Bath Royal United Hospital; 10, Circus, Bath.

1893 *Cole, Robert Henry*, M.D., Moorcroft, Hillingdon, Uxbridge.

1891 *Cook, Herbert George*, M.D., B.S., 22, Newport road, Cardiff.

1899 *Corrigan, William Jenkinson*, Cloughmore, Splott avenue, Cardiff.

1891 *Coumbe, John Batten*, M.D., 64, Caeran road, Newport, Mon.

1869 *Cresswell, Pearson R.*, C.B., Senior Surgeon to the Merthyr General Hospital; Dowlais, Merthyr Tydfil.

1892 *Cross, Francis Richardson*, M.B., Ophthalmic Surgeon to the Bristol Royal Infirmary, and Surgeon to the Bristol Eye Hospital; Worcester House, Clifton, Bristol.

1895 *Dardel, Jean*, M.D., Aix-les-Bains, Savoy.

Elected

1874 *Davidson, Alexander*, M.D., Consulting Physician to the Liverpool Royal Infirmary; Emeritus Professor, University College, Liverpool; 2, Gambier terrace, Liverpool.

1878 *Davy, Richard*, Consulting Surgeon to the Westminster Hospital; Burstone House, Bow, North Devon. *Trans.* 1.

1882 *Dawson, Yelverton*, M.D., Heathlands, Southbourne-on-Sea, Hants.

1889 *Delépine, Sheridan*, B.Sc., M.B., C.M., Professor of Pathology, Owens College, Manchester. *Trans.* 1.

1899 *Douglas, Archibald Robert John*, M.B., B.S., 500, Lordship Lane, Dulwich.

1902 *Douty, E. H.*, M.D., Davos, Switzerland.

1867 *Drage, Charles*, M.D., Hatfield, Herts.

1898 *Dreschfeld, Julius*, Farndon House, Rusholme, Manchester.

1885 *Drummond, David*, M.D., 7, Saville place, Newcastle-on-Tyne.

1880 *Drury, Charles Dennis Hill*, M.D., Bondgate, Darlington.

1899 *Drury, Edward Guy Dru*, M.B., B.S., Grahamstown, South Africa.

1871 *Dukes, Clement*, M.D., B.S., Physician to Rugby School, and Senior Physician to the Hospital of St. Cross, Rugby; Sunnyside, Rugby, Warwickshire.

1867 *Dukes, Major Charles*, M.D., Clarence Villa, Torrs park, Ilfracombe, North Devon.

1889 *Duncan, John*, M.D., St. Petersburg, Russia.

1894 *Durham, Herbert Edward*, M.B., Pathological Laboratory, Cambridge. *Trans.* 2.

1872 *Eager, Reginald*, M.D., Northwoods, near Bristol.

1887 *Easmon, John Farrell*, M.D., Assistant Colonial Surgeon, Gold Coast Colony, and Acting Chief Medical Officer of the Colony; Accra, Gold Coast, West Africa.

Elected

1898 EDKINS, J. S., Brambles, Watford road, Northwood.

1887 *ELLIOTT, JOHN*, 24, Nicholas street, Chester.

1868 *ELLIS, JAMES*, M.D., The Sanatorium, Anaheim, Los Angeles County, California.

1889 *ELLISTON, WILLIAM ALFRED*, M.D., Stoke Hall, Ipswich.

1903 *ETLINGER, FREDERICK KINCAID*, Cotswold Sanatorium, nr. Stroud, Gloucestershire.

1875 *Fagan, JOHN*, Consulting Surgeon to the Belfast Royal Hospital; 20, Fitzwilliam place, Dublin.

1897 *FAGGE, THOMAS HENRY*, M.D., Villa de la Porte Rouge, Monte Carlo.

1869 *FAIRBANK, FREDERICK ROYSTON*, M.D., Westcott, Dorking.

1872 *Fenwick, JOHN C. J.*, M.D., Physician to the Durham County Hospital; Long Framlington, Morpeth.

1903 *FERGUSON, GEORGE BAGOT*, M.D., M.Ch., Cheltenham.

1879 *FINLAY, DAVID WHITE*, M.D., Professor of the Practice of Medicine in the University of Aberdeen; Physician and Lecturer on Clinical Medicine to the Aberdeen Royal Infirmary; Consulting Physician to the Royal Hospital for Diseases of the Chest, London; 2, Queen's terrace, Aberdeen. *Referee*, 1891-3. *Trans.* 2.

1864 *Folker, WILLIAM HENRY*, Consulting and late Hon. Surgeon to the North Staffordshire Infirmary; Bedford House, Hanley, Staffordshire.

1903 *FORBES, NORMAN HAY*, Drumminnor, Calverley Park, Tunbridge Wells.

1896 *FORESTIER, HENRI*, M.D., Aix-les-Bains, Savoie, France.

1892 *FOSTER, MICHAEL GEORGE*, M.A., M.D., Villa San Giovanni, San Remo.

1884 *Franks, SIR KENDAL*, M.D., c/o J. H. Franks, Esq., C.B., Dalriada, Blackrock, co. Dublin. *Trans.* 2.

1903 *Freeborn, JOHN C. R.*, 38, Broad street, Oxford.

1876 *FURNER, WILLOUGHBY*, M.D., Surgeon to the Sussex County Hospital; Brunswick square, Brighton.

Elected

1864 *Gairdner, Sir William Tennant*, M.D., K.C.B., LL.D., F.R.S., Honorary Physician in Ordinary to H.M. the King in Scotland; formerly Professor of the Practice of Medicine in the University of Glasgow; Honorary Consulting Physician to the Western Infirmary, Glasgow; 32, George square, Edinburgh. *Trans.* 1.

1885 *Gamgee, Arthur*, M.D., LL.D., F.R.S., Emeritus Professor of Physiology in the Owens College, Victoria University, Manchester; Montreux, Switzerland.

1867 *Garland, Edward Charles*, Yeovil, Somerset.

1879 *Garstang, Thomas Walter Harropp*, Edge Mount, Altrincham.

1889 *Gaskell, Walter Holbrook*, M.D., F.R.S., Lecturer on Physiology, University of Cambridge; The Uplands, Great Shelford, Cambs.

1884 *Gibbes, Heneage*, M.D., Health Officer, Detroit, Michigan, U.S.A.

1897 *Gibson, George Alexander*, M.D., D.Sc., 3, Drumsheugh Gardens, Edinburgh.

1897 *Gilford, Hastings*, Norwood House, King's road, Reading. *Trans.* 2.

1893 *Gordon, William*, M.B., M.C., The Old Rectory, Goring-on-Thames, Oxon.

1890 *Gordon, William*, M.D., Barnfield Lodge, Exeter. *Trans.* 1.

1898 *Granville, Alexander*, Turf Club, Cairo.

1898 *Gray, J. A.*, M.B., Wadham Lodge, Uxbridge road, Ealing.

1889 *Greene, George Edward Joseph*, M.A., D.Sc., F.L.S., Monte Vista, Ferns, County Wexford.

1875 *Greenfield, William Smith*, M.D., Professor of Pathology and Clinical Medicine in the University of Edinburgh; 7, Heriot row, Edinburgh. *Sci. Com.* 1879. *Referee*, 1881.

1900 *Greer, William Jones*, 2, Chepstow road, Newport, Mon.

1882 *Gresswell, Dan Astley*, M.A., M.D., D.P.H., Chairman, Board of Public Health, Melbourne, Victoria.

Elected

1889 *Griffiths, Joseph*, M.A., M.D., C.M., Reader in Surgery in the University of Cambridge; Surgeon to Addenbrooke's Hospital; 63, Trumpington street, Cambridge. *Pro.* 1.

1889 *Gubb, Alfred S.*, M.D., Mustapha Supérieur, Algiers.

1870 *Hamilton, Robert*, Consulting Surgeon to the Royal Southern Hospital, Liverpool; Magherabuoy, Portrush, co. Antrim, Ireland.

1864 **Harley,** *John*, M.D., F.L.S., Hon. Physician to St. Thomas's Hospital; Consulting Physician to the London Fever Hospital; Beeding, Pulborough, Sussex. S. 1875-7. C. 1879-80. V.P. 1895-7. *Referee*, 1871-4, 1882-95. *Sci. Com.* 1879. *Trans.* 10.

1880 *Harris, Vincent Dormer*, M.D., Consulting Physician to the City of London Hospital for Diseases of the Chest, Victoria Park; the Royal National Hospital for Consumption and Diseases of the Chest, Ventnor; the Metropolitan Dispensary and the Morley House Convalescent Institutions, St. Margaret's Bay and Sandgate, etc.; Woodrouffe House, Milford-on-Sea, near Lymington, Hants. *Referee*, 1899—.

1901 *Hartigan, T. J. P.*, "Heathcote," East Grinstead, Sussex.

1890 *Haviland, Frank Papillon*, M.D., B.C., 57, Warrior square, St. Leonard's-on-Sea.

1885 *Hawkins, Francis Henry*, M.D., Physician to the Royal Berkshire Hospital; 73, London street, Reading. *Trans.* 1.

1900 *Hayford, Ernest James*, M.D., c/o The Agent, Claude's Ashanti Goldfields, Limited, Cape Coast Castle, Gold Coast.

1860 **Hayward,** *Henry Howard*, Consulting Surgeon Dentist to St. Mary's Hospital; 16, Blakesley avenue, Ealing. C. 1878-9.

1899 *Hind, Henry*, Harrogate.

Elected

1900 *Hobhouse, Edmund*, M.D., 36, Brunswick place, Brighton.

1843 **Holden,** *Luther*, Consulting Surgeon to St. Bartholomew's Hospital, Pinetoft, Ipswich. C. 1859. L. 1865. V.P. 1874. *Referee*, 1866-7. *Lib. Com.* 1858.

1894 *Holland, James Frank*, M.D., St. Moritz, Engadine Switzerland.

1868 *Hollis, William Ainslie*, M.D., Physician to the Sussex County Hospital ; 1, Palmeira avenue, Hove. *Trans.* 1.

1881 *Howard, Henry*, M.B., Medical Officer of Health, Williamstown, Melbourne, Victoria.

1898 *Hulke, S. Backhouse*, Ivy House, Walmer, Kent.

1882 *Humphry, Laurence*, M.D., 3, Trinity street, Cambridge.

1883 *Jacobson, Walter Hamilton Acland*, M.Ch.Oxon., Surgeon to Guy's Hospital ; Lordine Court, Ewhurst, Hawkhurst. C. 1902-3. *Referee*, 1895-1902. *Lib. Com.* 1896-1902. *Trans.* 2.

1883 *Jenkins, Edward Johnstone*, M.D., The Australian Club, Sydney, New South Wales.

1881 *Jennings, William Oscar*, M.D., 74, Avenue Marceau, Paris.

1901 *Johnson, Edward Angas*, M.B., St. Catharine's, Prospect, South Australia.

1876 *Jones, Leslie Hudson*, M.D., Limefield House, Cheetham hill, Manchester.

1875 *Jones, Philip Sydney*, M.D., Consulting Surgeon to the Sydney Infirmary ; 10, College street, Sydney, New South Wales. [Agents : Messrs. D. Jones & Co., Wool Exchange, Coleman Street, E.C.]

1865 *Jordan, Furneaux*, Consulting Surgeon to the Queen's Hospital, Birmingham ; Harborne, near Birmingham.

1890 *Kerr, J. G. Douglas*, M.B., C.M., 6, The Circus, Bath.

1884 *Keser, Jean Samuel*, M.D., Villa Colatel, Chemin Vinet, Lausanne, Switzerland.

Elected

1877 *Khory, Rustomjee Naserwanjee,* M.D.Brux., Hormazd Villa, Khumballa hill, Bombay.

1898 *Klefstad-Sillonville, O.,* M.D., Aix-les-Bains, Savoie.

1889 *Lancaster, Ernest le Cronier,* M.B., B.Ch., Assistant Physician to the Swansea Hospital; Hon. Physician to the Swansea and South Wales Institution for the Blind; Winchester House, Swansea, S. Wales.

1873 *Larcher, O.,* M.D., Laureate of the Institute of France, of the Medical Faculty, and Academy of Paris, &c.; 97, Rue de Passy, Passy, Paris.

1862 *Latham, Peter Wallwork,* M.D., Downing Professor of Medicine, Cambridge University, 1874–94; Senior Physician to Addenbrooke's Hospital, Cambridge; 17, Trumpington street, Cambridge.

1880 *Laycock, George Lockwood,* M.B., C.M., Melbourne, Victoria, Australia.

1892 *Lazarus-Barlow, Walter Sydney,* M.D., Fernholme, Woodside Park, N. *Sci. Com.* 1892—1902.

1886 *Lediard, Henry Ambrose,* M.D., Surgeon to the Cumberland Infirmary; 35, Lowther street, Carlisle. *Trans.* 1.

1882 *Ledwich, Edward l'Estrange,* Anatomist to the Royal College of Surgeons, Ireland; 30, Upper Fitzwilliam street, Dublin.

1883 *Leeson, John Rudd,* M.D., C.M., Clifden House, Twickenham.

1869 *Legg, John Wickham,* M.D. C. 1886. *Referee,* 1882-5. *Lib. Com.* 1878-85. *Trans.* 2.

1898 *Lindsay, James,* M.A., M.D., 13, College square East, Belfast.

1889 *Little, James,* M.D., Physician to the Adelaide Hospital; 14, Stephen's Green North, Dublin.

1894 *Lowe, Thomas Pagan,* 16, The Circus, Bath.

Elected

1889 *MacAlister, Donald*, M.A., B.Sc., M.D., Physician to Addenbrooke's Hospital; Linacre Lecturer and Tutor, St. John's College; University Lecturer in Medicine, St. John's College, Cambridge.

1887 *Macdonald, George Childs*, M.D. (Address uncommunicated.)

1866 *Macgowan, Alexander Thorburn*, M.D., Vyvian House, Clifton park, Bristol.

1876 *Mackey, Edward*, M.D., Physician to the Sussex County Hospital; Senior Physician to the Royal Alexandra Hospital for Sick Children; 1, Ventnor villas, Hove.

1854 *Mackinder, Draper*, M.D., 12, Park View Villas, Hove, Sussex.

1893 *MacLeod, Surgeon-Colonel Kenneth*, M.D., The Towers, Woolston, S. Hants.

1876 *Macnamara, N. Charles*, Consulting Surgeon to the Westminster Hospital, and to the Royal Westminster Ophthalmic Hospital; The Lodge, Chorley Wood. C. 1891-2. V.P. 1902-4. *Referee*, 1884-90, 1895-7. *Lib. Com.* 1886-90.

1891 *Manby, Alan Reeve*, M.V.O., M.D., Surgeon Apothecary to His Majesty's Household at Sandringham and to T.R.H. the Prince and Princess of Wales at Sandringham; East Rudham, Norfolk.

1894 *Marriott, Charles William*, M.D., Aubrey House, Bath road, Reading.

1892 *Martin, Christopher*, M.B., C.M., Surgeon to the Birmingham and Midland Hospital for Women; 35, George road, Edgbaston, Birmingham.

1899 *Martyn, Gilbert John King*, M.D., 8, Gay street, Bath.

1883 *Maudsley, Henry Carr*, M.D., 22, Collins street, Melbourne, Victoria.

1839 *Meade, Richard Henry*, Consulting Surgeon to the Bradford Infirmary; Bradford, Yorkshire. *Trans.* 1.

1897 *Merry, William Joseph Collings*, M.D., B.Ch., 2, Chiswick place, Eastbourne.

Elected

1898 *Millard, William Joseph Kelson*, M.D., Trediden, Hewlett road, Cheltenham.

1895 *Mills-Roberts, Robert Herbert*, Hafod-ty, Llanberis, North Wales.

1896 *Moore, Sir John*, M.D., 40, Fitzwilliam square west, Dublin.

1891 *Morris, Graham*, Wallington, Surrey.

1894 *Morse, Thomas Herbert*, All Saints' Green, Norwich. *Trans.* 1.

1902 *Moynihan, Berkeley George Andrew*, M.S., 33, Park square, Leeds. *Trans.* 2.

1899 *Mundy, Herbert*, Kennington, Oxford (c/o Fleming Johnston, 460, West Street, Durban).

1892 *Myddelton-Gavey, E. Herbert*, 16, Broadwater Down, Tunbridge Wells.

1881 *Nall, Samuel*, M.B., Dryhurst Lodge, Disley, Stockport.

1889 *Napier, Francis Horatio*, M.B., Cape Town.

1870 *Neild, James Edward*, M.D., Lecturer on Forensic Medicine and Psychological Medicine in the University of Melbourne; 21, Spring street, Melbourne, Victoria.

1902 *Newland, Henry Simpson*, M.B., Ch.B., Adelaide, South Australia.

1895 *Newsholme, Arthur*, M.D., 11, Gloucester place, Brighton. *Trans.* 1.

1868 *Nicholls, James*, M.D., Trekenning House, St. Columb, Cornwall.

1847 *Nourse, William Edward Charles*, Norfolk Lodge, Thurloe road, Torquay.

1880 *O'Connor, Bernard*, A.B., M.D., Senior Physician to the North London Hospital for Consumption; 25, Hamilton road. Ealing.

1855 *Ogle, William*, M.A., M.D., Consulting Physician to the Royal Derbyshire Infirmary; The Elms, Duffield road, Derby.

Elected

1870 *Oldham, Charles Frederic*, India [Agents: Messrs. Grindlay and Co., 55, Parliament street].

1896 *Oliver, George*, M.D., Riversleigh, Farnham, Surrey, and Harrogate.

1883 *Oliver, Thomas*, M.A., M.D., Professor of Physiology, University of Durham; and Physician to the Newcastle-on-Tyne Infirmary; 7, Ellison place, Newcastle-on-Tyne. *Trans.* 1.

1871 *O'Neill, William*, M.D., C.M., late Physician to the Lincoln Lunatic Hospital, and Physician, Lincoln General Dispensary, &c.; 2, Lindum road, Lincoln.

1890 *Ord, William Wallis*, M.D., The Hall, Salisbury.

1885 *Ormsby, L. Hepenstal*, M.D., Lecturer on Clinical and Operative Surgery and Surgeon to the Meath Hospital and County Dublin Infirmary; Surgeon to the Children's Hospital, Dublin; 92, Merrion square West, Dublin.

1894 *Osborn, Samuel*, Knight of Grace of St. John; Maisonnette, Datchet, Bucks.

1887 *Paget, Charles Edward*, Medical Officer of Health to the County Council of Northamptonshire; County Hall, Northampton.

1858 *Paley, William*, M.D., Physician to the Ripon Dispensary; Yore Bank, Ripon, Yorkshire.

1887 *Pardington, George Lucas*, M.D., 47, Mount Pleasant road, Tunbridge Wells.

1873 *Parker, Robert William*, Consulting, late Senior Surgeon to the East London Hospital for Children and to the German Hospital; Caryll Hurst, West Grinstead, Sussex. C. 1888-9, 1899—1901. S. 1895-8. *Bldg. Com.* 1889-92. *Referee*, 1891-5. *Lib. Com.* 1885-87, 1892-5, 1898-9. *Ho. Com.* 1892-5, 1899—1901. *Trans.* 4.

Elected

1885 *Parker, Rushton*, M.B., B.S., Professor of Surgery, University College. Liverpool (Victoria University); Surgeon to the Liverpool Royal Infirmary; 59, Rodney street, Liverpool.

1891 *Parkin, Alfred*, M.S., M.D., 24, Albion street, Hull. *Trans.* 1.

1879 *Peel, Robert*, 120, Collins street East, Melbourne, Victoria.

1874 *Penhall, John Thomas*, The Cedars, Broadwas-on-Teme, Worcester.

1897 *Perram, Charles Herbert*, M.D., 55, Bromham Road, Bedford.

1879 *Pesikaka, Hormasji Dosabhai*, 43, Hornby road, Bombay.

1878 *Philipson, Sir George Hare*, M.D., D.C.L., Professor of Medicine in Durham University; Consulting Physician to the Newcastle-upon-Tyne Royal Infirmary; 7, Eldon square, Newcastle-upon-Tyne.

1898 *Phillips, L. C. Powell*, Kasr-el-Aini Hospital, Cairo.

1867 *Pick, Thomas Pickering*, Consulting Surgeon to St. George's Hospital; The Nook, Great Bookham, Surrey. C. 1884-5. V.-P. 1893-4. *Referee*, 1882-3, 1891-93. *Sci. Com.* 1870, 1889—. *Lib. Com.* 1879-81.

1891 *Pierce, Bedford*, M.D., The Retreat, York.

1897 *Pigg, T. Strangeways*, St. John's College, Cambridge.

1841 **Pitman**, *Sir Henry Alfred*, M.D., Consulting Physician to St. George's Hospital; Cranbrook, Bycullah park, Enfield. L. 1851-3. C. 1861-2. T. 1863-8. V.P. 1870-1. *Referee*, 1849-50. *Lib. Com.* 1847.

1871 *Poore, George Vivian*, M.D., late Professor of Medical Jurisprudence and Clinical Medicine in University College, London; Consulting Physician to University College Hospital; Priory Lodge, Andover, Hants. C. 1890-91. *Referee*, 1887-9, 1892-1904. *Lib. Com.* 1895-1904. *Trans.* 2.

Elected

1892 *Powell, Herbert Andrews*, M.A., M.D., M.Ch., Piccards Rough, Guildford.

1900 *Price-Jones, Cecil*, M.B., 7, Claremont road, Surbiton, Surrey.

1897 *Quartey-Papafio, Benjamin William*, M.D., Accra, Gold Coast, West Africa.

1857 *von Ranke, Henry*, M.D., 3, Sophienstrasse, Munich.

1890 *Ransom, William Bramwell*, M.D., Physician to the Nottingham General Hospital; The Pavement, Nottingham. *Trans.* 1.

1854 *Ransom, William Henry*, M.D., F.R.S., Consulting Physician to the Nottingham General Hospital; 17, Park Valley, Nottingham. *Trans.* 1.

1902 *Raw, Nathan*, M.D., B.S., 66, Rodney street, Liverpool.

1884 *Reid, Thomas Whitehead*, M.D., Surgeon to the Kent and Canterbury Hospital; St. George's House, Canterbury, Kent.

1901 *Reissmann, Charles Henry*, M.D., B.C., B.Sc., St. Peter's, College Green, Adelaide, South Australia.

1881 *Rice, George*, M.B., C.M., Sutton, Surrey.

1889 *Rivers, W. H. Rivers*, M.D., St. John's College, Cambridge.

1871 *Roberts, David Lloyd*, M.D., F.R.S.E., Consulting Obstetric Physician to the Manchester Royal Infirmary; Physician to St. Mary's Hospital, and Lecturer on Clinical Obstetrics and Gynæcology at the Owens College, Manchester; 11, St. John street, Manchester.

1889 *Roberts, Leslie*, M.D., 46, Rodney street, Liverpool.

1873 *Robertson, William Henry*, M.D., Consulting Physician to the Buxton Bath Charity and Devonshire Hospital; Buxton, Derbyshire.

1888 *Robinson, Frederick William*, M.D., C.M., Huddersfield.

1885 *Rockwood, William Gabriel*, M.D., Colombo, Ceylon.

Elected

1898 *Rogers, Leonard,* I.M.S. [care of Messrs. Watson & Co., Calcutta.] *Trans.* 3.

1863 *Rowe, Thomas Smith,* M.D., Consulting Surgeon to the Royal Sea-Bathing Infirmary; Union crescent, Margate, Kent.

1891 *Ruffer, Marc Armand,* M.D., The Quarantine Board, Alexandria.

1855 **Sanderson,** *Sir John Burdon, Bart.,* M.D., LL.D., D.C.L.Durham, D.Sc., F.R.S., late Regius Professor of Medicine in the University of Oxford; 64, Banbury road, Oxford. C. 1869-70. V.P. 1882. *Referee,* 1867-8, 1876-81. *Sci. Com.* 1862, 1870. *Lib. Com.* 1876-81. *Trans.* 2

1867 *Sandford, Folliott James,* M.D., V.D., late Surgeon-Major, 2nd Batt. S.V.L.Infy., now Hon. Surgeon-Major; Surgeon to the Market Drayton Dispensary, and Consulting Physician to the Market Drayton Cottage Hospital; Market Drayton, Shropshire.

1886 *Saundby, Robert,* M.D., LL.D., Physician to the General Hospital, and Consulting Physician to the Hospital for Women, and to the Eye Hospital, Birmingham; Professor of Medicine, Mason University College; 140B. Great Charles street, Birmingham.

1883 *Schäfer, Edward Albert,* LL.D., F.R.S., Professor of Physiology in the University of Edinburgh. C. 1899-1900. *Referee,* 1888-99. *Sci. Com.* 1889—. *Trans.* 1.

1861 *Scott, William,* M.D., Senior Physician to the Huddersfield Infirmary; Waverley House, Huddersfield.

1897 *Semple, Edward,* M.D., Grove house, Fenstanton, Hunts.

1899 *Shuttleworth, George Edward,* M.D., Ancaster House, Richmond Hill.

1887 *Sidebotham, Edward John,* M.B., Erlesdene, Bowdon, Cheshire.

Elected

1857 *Siordet, James Lewis,* M.B., Villa Cabrolles, Mentone, Alpes Maritimes, France.

1896 *Sloane, John Stretton,* M.B., B.S., B.Sc., 7, Highfield street, Leicester.

1891 *Smith, G. Cockburn,* M.D., 14, South road, Newton Abbot.

1902 *Smith, Harry Lyon,* M.D., Woodfield House, Uppingham, Rutland.

1886 *Smith, Howard Lyon,* Buckland House, Buckland Newton, Dorchester.

1894 *Smith, Robert Shingleton,* M.D., B.Sc., Deepholm, Clifton Park, Clifton, Bristol.

1894 *Smith, Thomas Rudolph,* M.B., B.C., Blytheholm, Stockton-on-Tees.

1868 *Solly, Samuel Edwin,* Colorado Springs, Colorado, U.S.A.

1891 *Stevens, Surg.-Capt. Cecil Robert,* M.B., B.S., I.M.S., Eden Hospital, Calcutta.

1854 *Stevens, Henry,* M.D., late Inspector, Medical Department, Local Government Board, Whitehall; Durham Lodge, St. Margaret's road, Twickenham.

1884 *Stewart, Edward,* M.D., Brook House, East Grinstead.

1879 *Stirling, Edward Charles,* M.D., Senior Surgeon to the Adelaide Hospital; Lecturer on Physiology in the University of Adelaide, South Australia [care of Messrs. Elder and Co., 7, St. Helen's place].

1871 *Strong, Henry John,* M.D., J.P., Consulting Surgeon to the Croydon General Hospital; Colonnade House, The Steyne, Worthing.

1890 *Sympson, E. Mansel,* M.D., B.C., Surgeon to the Lincoln County Hospital; Deloraine Court, Lincoln.

1886 *Teale, Thomas Pridgin,* M.B., F.R.S., Consulting Surgeon to the Leeds General Infirmary; 38, Cookridge street, Leeds.

Elected

1898 *Thomas, J. Lynn*, C.B., Surgeon to the Cardiff Infirmary; Consulting Surgeon to the Hamadryad Hospital; Green Lawn, Pen-y-lan, Cardiff.

1890 *Thomas, William Robert*, M.D., Little Forest, Bath road. Bournemouth.

1891 *Thomson, John Roberts*, M.D., Monkchester, Bournemouth.

1883 *Thursfield, Thomas William*, M.D., Physician to the Warneford and South Warwickshire General Hospital; Selwood, Beauchamp square, Leamington.

1880 *Tivy, William James*, 8, Lansdowne place, Clifton, Bristol.

1881 *Treves, William Knight*, Surgeon to the National Hospital for Scrofula; 31, Dalby square, Cliftonville, Margate.

1867 *Trotter, John William*, formerly Surgeon-Major, Coldstream Guards; 4, St. Peter's terrace, York.

1873 *Turner, George Brown*, M.D., Camden House, Hemel Hempsted, Herts.

1894 *Turner, Philip Dymock*, M.D., Sudbury, Isle of Wight.

1891 *Tweed, Reginald*, M.D., Hembury Fort Cross, Honiton, Devon.

1881 *Tyson, William Joseph*, M.D., Senior Medical Officer of the Victoria Hospital, Folkestone; 10, Langhorne Gardens, Folkestone.

1900 *Uhthoff, John Caldwell*, M.D., Wavertree House, Hove, Brighton.

1867 **Vintras**, *Achille*, M.D., late Physician to the French Embassy and Senior Physician to the French Hospital and Dispensary, Shaftesbury avenue; De Courcel road, Brighton.

1854 *Waddington, Edward*, Hamilton, Auckland, New Zealand.

Elected

1868 *Walker, Robert*, Clovelly, Bideford.

1867 *Wallis, George*, Consulting Surgeon to Addenbrooke's Hospital; 6, Hills road, Cambridge.

1899 *Walters, Frederick Rufenacht*, M.D., Crooksbury Sanatorium, Farnham, Surrey.

1883 *Walters, James Hopkins*, Surgeon to the Royal Berkshire Hospital; 15, Friar street, Reading.

1899 *Warde, Wilfred Brougham*, M.D., 13, Lonsdale Gardens, Tunbridge Wells.

1861 *Waters, A. T. Houghton*, M.D., Consulting Physician to the Royal Infirmary; 69, Bedford street, Liverpool. *Trans.* 3.

1874 *Wells, Harry*, M.D., San Ysidro, Buenos Ayres, S. America.

1882 *Wharry, Charles John*, M.D., 14, Ewell road, Surbiton, Surrey.

1881 *Whitehead, Walter*, F.R.S. Ed., Senior Surgeon to the Manchester Royal Infirmary, Manchester and Salford Lock Hospital, and Manchester and Salford Skin Hospital; Professor of Clinical Surgery, Owens College, Victoria University; 499, Oxford road, Manchester. *Trans.* 1.

1885 *Whitla, Sir William*, M.A., M.D., Professor of Materia Medica and Therapeutics, Queen's College, Belfast; Physician to, and Lecturer in Medicine at, the Belfast Royal Hospital; Consulting Physician to the Ulster Hospital for Women and Children; Consulting Physician to the Belfast Ophthalmic Hospital; 8, College square north, Belfast.

1870 *Wilkin, John F.*, M.D., Rose Ash Court, South Molton, Devon.

1883 *Willans, William Blundell*, Much Hadham, Herts.

1896 *Williams, Alfred Henry*, M.D., Rotorua, Harrow.

Elected

1859 ***Williams***, *Charles*, Senior Surgeon to the Norfolk and Norwich Hospital; 48, Prince of Wales road, Norwich.

1872 **Williams**, *Sir John*, Bart., K.C.V.O., M.D., Physician-Accoucheur to H.R.H. the Princess of Wales, Physician to H.R.H. the Princess Beatrice; Emeritus Professor of Obstetric Medicine, University College, London; Consulting Obstetric Physician to University College Hospital; Plâs Llanstephan, Carmarthenshire. C. 1891. *Referee*, 1878-90. *Lib. Com.* 1876-82.

1903. *Williamson, Richard Ernest*, M.B., C.M., Romagna House, Otley, Yorkshire.

1887 *Wilson, Arthur Hervey*, M.D., 504, Broadway, Boston, U.S.A.

1889 *Wise, A. Tucker*, M.D., Montreux, Switzerland.

1850 *Wise, Robert Stanton*, M.D., Consulting Physician to the Southam Eye and Ear Infirmary; Beech Lawn, Banbury.

1885 *Wolfenden, Richard Norris*, M.D., Rangemont, Seaford, Sussex.

1892 *Woodhead, German Sims*, M.D., Professor of Pathology in the University of Cambridge; 6, Scrope terrace, Cambridge.

1879 *Woodward, G. P. M.*, M.D., Deputy Surgeon-General; 157, Liverpool street, Hyde Park, Sydney, New South Wales.

1899 *Wynter, Andrew Ellis*, M.D., Corner House, Beckenham, Kent.

SERVICE FELLOWS.

1903 BENTHAM, ROBERT, Royal Naval Hospital, Plymouth.

1904 KELLIE, GEORGE JEROME, Sirur, Poonah District, c/o Messrs. H. S. King & Co., 9, Pall Mall.

1903 LEICESTER, JOHN HOLDICH, M.D., B.S., Eden Hospital, Calcutta.

1904 POLLOCK, CHARLES EDWARD, c/o Messrs. Holt & Co., 3, Whitehall Place.

1903 RANKING, ROBERT MAURICE, M.B., B.C., Hanover House, Tunbridge Wells.

1903 SMITHSON, ARTHUR ERNEST, M.B., B.C., Barberton, Transvaal, c/o C. R. McGregor, Bart & Co., 25, Charles Street, St. James's Square.

1903 TAYLOR, SIR WILLIAM, K.C.B., M.D., C.M., 68, Victoria street.

Corrected to 31st July, 1904.

ANNUAL GENERAL MEETING.

March 1st, 1904, at 5 p.m.

Present—ALFRED WILLETT, President;

CLINTON T. DENT, G. NEWTON PITT, } Hon. Secs.;

and 20 Fellows.

The President nominated Mr. Bowlby and Mr. Kiallmark as Scrutineers.

The Senior Hon. Secretary read the Report of the Council.

REPORT OF COUNCIL.

Since the last Annual Meeting 27 new Fellows have been elected, and the names of 18 Fellows have been removed from the List, owing either to death or resignation.

The following is a statement of the present number of Fellows:

Honorary Fellows—English . . .	5	
Foreign . . .	14	
	—	19
Fellows—Resident	539	
Non-resident . . .	289	
Service	5	
	—	833
		852

The new rule with regard to Service Fellows has now come into force. Although the number of Service Fellows up to the present is but small, the Council have good reason for supposing that, when the advantages become more widely known, the number will largely increase.

At the last Annual Meeting it was reported that the Society had received a legacy of £300 from Mr. E. U. Berry. With this money the Council have been able to set on foot the formation of a Card Catalogue for the Library—an improvement that has long been desired, and one that it is confidently hoped will prove of the greatest value to Fellows who make use of the Library. The advantage in a large and constantly increasing Library of having a Catalogue that is always up to date will be obvious to Fellows, and the name of so generous a benefactor as Mr. Berry will be most suitably associated with so permanent an improvement.

The Council have also to report that they have received a legacy of £100 from the late Dr. George Thin, who had been a Fellow of the Society since 1874.

The Sixth Award of the Marshall Hall Prize was made to Dr. Henry Head, whose name forms a worthy addition to the list of eminent scientific workers who had previously been recipients of the Prize.

A memorial brass recording the names of those to whom the Marshall Hall Prize has been awarded has been placed in the meeting-room.

A similar brass has been prepared to commemorate the

names of those who have benefited the Society by subscriptions to the Endowment Fund.

The Standing Orders of Council have been revised and reprinted, a proceeding rendered necessary by the fact that numerous alterations have been made from time to time, and that it was some years since they had last been printed. The Bye-laws, as they exist at present, have been reprinted, and appear at the end of vol. lxxxvi of the 'Transactions.'

The Council desire to draw the attention of Fellows to the fact that the Centenary of the Society occurs in 1905. Some preliminary steps have been taken in connection with the celebration of the Centenary, but no definite programme has as yet been finally adopted, as the Council recognise that the work of carrying out the arrangements will devolve upon their successors in office.

During the session the report from the committee appointed to investigate the question of Suspended Animation in the Drowned was presented to the Society. The report on this highly important subject is printed as a supplementary volume to the 'Transactions.'

Mr. Warrington Haward (Hon. Treasurer) read the Treasurers' Report, and explained the audited Statements of Accounts.

Report of the Honorary Treasurers.

"The Hon. Treasurers have pleasure in reporting that the financial condition of the Society is most satisfactory. The income for the year 1903, without including in the account a legacy of £300, exceeded that for 1902 by £361 16*s.* 10*d.*, and the income for the year exceeded the expenditure by £857 12*s.* 1*d.* The increase is mainly due to additional rents from tenants occupying the portion of your premises on which considerable sums were expended in

1902. The debenture debt has been further reduced by £400.

(Signed) W. S. CHURCH.
WARRINGTON HAWARD.

Report of the Honorary Librarians.

"The generous legacy of the late Mr. Edward Unwin Berry has enabled the Council to commence a long desired improvement, and important changes affecting the Library Catalogue and shelf arrangement of the books have been decided upon. The printing of the supplements to the catalogues will in future be discontinued, and a card catalogue is now nearly finished. The question of the reconstruction of the subject-index, the Library copy of which, in the lapse of years, has become overcrowded with entries, is also pressing, and will have to be undertaken in the near future.

"The books throughout the Library are to be re-numbered, and given fresh case marks and shelf marks—these to correspond exactly with the cases as numbered in the Library. Considerable progress has already been made in this work. In consequence of these new arrangements it has been found necessary to compile fresh Location Books, giving a duplicate record of the new numbers and shelf marks, and an abstract of the title of every volume or set of volumes in the Library.

"A space has recently been acquired at the back of the Meeting Room capable of holding some 10,000 volumes.

"The ordinary work of the Library has been fully kept up to its usual level, as the following figures show.

"The total number of books and pamphlets added to

the Library during the past year was 966, of which 582 were gifts from Fellows and others.

"The issues (apart from books used in the Library) were 3775. Its employment for reference purposes, apart from borrowing, is largely on the increase, for, on statistics kept over a period of six months, there has been an average of 452 Fellows and visitors in the Library per month, or about 5000 in the course of the year of eleven months.

"Three hundred and seventy-three volumes were borrowed from Lewis's Library as against 331 in 1902 and 258 in 1901. The borrowing of this large number is only possible upon a system of rapid exchange, and thanks are due to those Fellows who have assisted in facilitating this end by their prompt return of these extra volumes as soon as they have done with them.

"NORMAN MOORE, M.D.
"RICKMAN J. GODLEE."

The President moved—

"That the Report of the Council, together with the Treasurers' Statement of Accounts, be adopted."

Carried unanimously.

The President then called upon Mr. Warrington Haward (Hon. Treasurer) to explain the changes in the Bye-laws, of which notice had been given by the Council, viz.:

"CHAPTER V:

Section 1, *line* 5.—The word 'three' has been substituted for the word 'six.'

„ 1, *lines* 6 and 7.—The words 'which sum shall not be held to include an annual contribution' have been struck out; also the word 'afterwards.'

„ 3.—Everything after the words 'current year' has been struck out.

Section 5, *lines* 29 and 30.—The words 'after the eighth day of June, 1897,' have been struck out.

„ 5, *lines* 33, 34, and 35.—All the words between 'shall' in line 33, and 'contribute' in line 35, have been struck out.

„ 5 (p. 15), *lines* 3 and 4.—The words 'an additional three guineas, as admission fee and' have been struck out.

„ 6 has been struck out."

Mr. Warrington Haward—

"The Council have made these alterations in the Bye-laws because it came to their knowledge that many candidates for the Fellowship of the Society were not aware that if they were elected within three months preceding the Annual Meeting the Admission Fee of Six Guineas exempted them from any further contribution until the second Annual Meeting from the time of election. The Bye-laws were not very clear on this point, and misconstruction occurred not infrequently, as was apparent from the fact that it was not uncommon for the Secretary to receive a cheque for Nine Guineas on the admission of a Fellow, who thought he was liable for the subscription of Three Guineas, in addition to the Admission Fee of Six Guineas. To clear away this obscurity, and to make it apparent that we are not asking for what might seem an exorbitant contribution, it was decided to do away with the exemption which at present exists from the subscription for the first year, and to make the Admission Fee for the Residents the same as that for the Non-residents, which now stands at Three Guineas; so that all Fellows will be admitted on the same fee. We hope this will prevent any misconstruction as to the liabilities which are incurred on admission, and that candidates may thus be encouraged to

come at an earlier period into the ranks of the Society.

"If you confirm the alteration, the Bye-law will then read (Chapter V, Section 1) :

> 'Every person elected a Fellow of the Society, and living within seven miles of the Society's House, shall, previously to his admission, pay to the Society the sum of Three Guineas as an admission fee, and shall contribute the sum of Three Guineas annually.'

"That is to say he will pay on admission Three Guineas for his Admission Fee and Three Guineas for his first year's contribution.

"The next alteration is in Section 6, which reads :

> 'The Annual Contribution shall be payable at each Annual General Meeting for the current year; but no Fellow elected within three months preceding the Annual Meeting shall be liable to such contribution until the second Annual General Meeting from the time of his election.'

"We have cut out all the latter part of that paragraph, so that it reads as follows :

> 'The Annual Contribution shall be payable at each Annual General Meeting for the current year.'

"Section 6, referring to the contributions of Non-resident Fellows, has been altered to read as follows :

> 'Every person who shall be elected a Fellow of the Society, and does not live within seven miles of the Society's House, shall pay to the Society the sum of Three Guineas as an admission fee, and shall contribute the sum of One Guinea annually, and shall be entitled,' etc.

"Then, with regard to the terms on which a Non-resident Fellow can become a Resident Fellow

or have the privileges of a Resident Fellow, the paragraph in Section 5 now reads:

> 'Any Non-resident Fellow wishing to enjoy the full privileges of a Resident Fellow, shall be at liberty to do so on paying an Annual Contribution of Three Guineas.'

"He merely alters his subscription, his Admission Fee having already been paid as explained.

"Section 6 has thus become unnecessary, and we propose to expunge it.

"I hope I have made these matters clear, and I beg to move that the changes in the Bye-laws be confirmed."

Carried unanimously.

The President then read his Annual Address (see p. cvii).

At six o'clock the President called upon the Scrutineers to close the ballot, and to report the result.

The Scrutineers announced the result of the ballot to be as follows:

President.—Sir Richard Douglas Powell, Bart., M.D., K.C.V.O.

Vice-Presidents.—Henry Charlton Bastian, M.D., F.R.S.; Walter Butler Cheadle, M.D.; Henry Trentham Butlin; Alfred Pearce Gould, M.S.

Honorary Treasurers.—Sir William Selby Church, Bart., M.D., K.C.B.; J. Warrington Haward.

Honorary Secretaries.—George Newton Pitt, M.D.; Stephen Paget.

Honorary Librarians.—Norman Moore, M.D.; Rickman J. Godlee, M.S.

Members of Council.—William Lambert Brown, M.D.; Thomas Lewis Fox, M.B.; George Alan Heron, M.D.; Leonard William James Hunt, M.D., C.M.; Sir James Reid Laws, K.B.E., M.D.; William Boyd, B.S.; William Whitmore Lane, M.S.; William Lang Lumsden Stephen, C.M.G.; Edmund Sanders Wynn.

Sir J. Lorrain Smith said:—

"That the best thanks of the Society be given to the President, Sir Alfred Wiles, for his most valuable services to the Society during the term of office now about to terminate, and that he be requested to allow the address just delivered to be printed in the Transactions."

I think we all know what a debt we owe to Sir Alfred Wiles for the valuable services he has rendered to the Society during the term of his Presidency. We have had the benefit of his wise counsel and guidance in the Council, and we have had the benefit of his wide knowledge and experience in the chair. Every one of us will feel that we have lost a friend. I am sure we all feel that we have had a most able and courteous President, and we shall look forward with pleasure to the time when he will be able to resume his duties in the Society. I am sure that we shall all wish him a speedy recovery from his illness, and we hope that he will be able to be with us for many years to come.

Seconded by Sir James Reid Laws, K.B.E., M.D., and carried by acclamation.

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> 'Any Non-resident Fellow wishing to enjoy the full privileges of a Resident Fellow, shall be at liberty to do so on paying an Annual Contribution of Three Guineas.'

"He merely alters his subscription, his Admission Fee having already been paid as explained.

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Honorary Librarians.—Norman Moore, M.D.; Rickman J. Godlee, M.S.

Members of Council.—William Radford Dakin, M.D.; Thomas Colcott Fox, M.B.; George Allan Heron, M.D.; Donald William Charles Hood, M.D., C.V.O.; Sir James Reid, Bart., G.C.V.O., K.C.B., M.D.; Stanley Boyd, B.S.; William Arbuthnot Lane, M.S.; William Lang; Charles Stonham, C.M.G.; Edmund Johnson Spitta.

Sir R. Douglas Powell moved—

"That the best thanks of the Society be given to the President, Mr. Alfred Willett, for his most valuable services to the Society during his term of office, and that he be requested to allow the Address, just delivered, to be printed in the 'Transactions.'"

I think, sir, that there are some of us here who have deeply felt the censure which you so gently conveyed to us for our inadequate attendance at the meetings of this Society, and we have felt grateful to you for the kindly ingenuity with which you excused our shortcomings. Those of us who have been at these meetings have not failed to recognise the great courtesy, dignity, and ability with which you have presided over those meetings and encouraged the discussions at them. (Hear, hear.) Those of us who have been at the Council meetings of the Society have been greatly impressed by the judgment, tact, and ability with which you have presided over the business affairs of this Society. Further, I am sure that we wish to convey to you our thanks for the very able address to which we have just listened, containing very many valuable points for our very careful consideration, and containing, as it did, a very interesting outline of the lives of those who have departed from us in the past year, and whose memories will rest for our own edification.

Seconded by Dr. Pollock, who said: I have great pleasure in seconding the resolution, and thank you for

the able address you have delivered this evening, and also for the long services which you have rendered to the Society.

Carried unanimously.

The President.—I have to thank Sir Douglas Powell and Dr. Pollock for the very kind remarks which they have applied to me on my retirement. It has been a very great honour to preside over this Society, and I am very grateful to the Fellows for having placed me in that position. I must return you my most sincere thanks, and I would also take this opportunity of returning my most cordial thanks to all the members of the Council for their unvarying courtesy and support to me in carrying out the duties of the office. I assure you, gentlemen, till the end of my days I shall always treasure the recollection that I have held this office which you have so kindly placed me in. (Hear, hear.)

Mr. J. A. Kingdon moved, and Mr. Reginald Harrison seconded—

"That the best thanks of the Society be given to the retiring Vice-Presidents for their services to the Society during their respective terms of office, viz. Sir Richard Douglas Powell, Sir Dyce Duckworth, Mr. N. Charles Macnamara, and Mr. Edgcombe Venning."

Carried unanimously.

Dr. Shuttleworth moved—

"That the best thanks of the Society be given to the retiring Honorary Secretary, Mr. Clinton Dent, for his most able and valuable services to the Society during his term of office."

I could wish that the proposing of this resolution had fallen into the hands of some Fellow senior to myself, but I have the consolation of knowing that it is a resolution which, without any words of mine, cannot fail to be

acceptable to the Society. It would be somewhat commonplace to say how much the welfare of any Society, especially a Society like this, and how much the interest of its proceedings depend upon the ability of the Secretaries. You, sir, have already referred to the strenuousness with which Mr. Clinton Dent has performed a portion of the duties of his office,—you referred specially to the aid which he has given in the re-modelling of the Bye-laws and the Standing Orders of the Society. But we all know—all who have had the opportunity of attending meetings—how much we owe him for the manner in which these meetings have been arranged, and how much those who have contributed papers and taken part in discussions owe to him and his co-Secretary for the urbanity and courtesy with which everyone who has had occasion to communicate with the Secretary has been treated.

Mr. F. Durham, in seconding, said: It gives me very much pleasure to second this resolution. Mr. Dent has worked so well for the Society, and so much of the success of which we have heard to-night depends upon his able and valuable services, that I am sure we shall all join in according him our most cordial thanks.

Carried unanimously.

The President.—I would like to add to what has fallen from the proposer and seconder that it is impossible for us to be sufficiently grateful to Mr. Dent for all that he has done for this Society.

Mr. Clinton Dent.—It is in accordance with tradition that I rise for a very brief moment to thank the mover and seconder of this resolution, and you also, sir, very heartily for the kind way in which you have referred to myself. The duties of the Honorary Secretary of this Society, if he does them, are tolerably onerous, and I must confess that at times I have looked forward to the termination of my period of office. Now that the time has come I am sorry to leave. Sorry to leave it because it has thrown

me into association with Presidents like Dr. Pavy and yourself, sir, who have always known admirably how to maintain the progress and yet observe the traditions of the Society; I am sorry to leave it because it has brought me into friendly contact with so many others connected with the working of the Society, particularly the officials, who are not usually mentioned on this occasion,—that is, the permanent staff of the Society. The Honorary Secretary knows better than anybody else how much ungrudging, unselfish, and genuinely honest work is done by the permanent officials of the Society, and I think perhaps the Fellows scarcely appreciate that fact sufficiently. I am sorry to leave it on all these accounts, but my regret is tempered by the thought that the affairs of the Society, as regards the Honorary Secretaries, are in the tried hands of my friend, Dr. Newton Pitt, and in the hands of one who will certainly not fail to do better than I have, Mr. Stephen Paget.

Carried unanimously.

Dr. Bowles moved—

> "That the best thanks of the Society be given to the retiring members of Council for their services to the Society during their respective terms of office, viz. Dr. Radcliffe Crocker, Dr. Garrod, Dr. Goodhart, Dr. Herringham, Dr. Amand Routh, Mr. Boyce Barrow, Mr. Bowlby, Mr. Gunn, Mr. G. R. Turner."

Seconded by Dr. Coupland.

Carried unanimously.

The President.—There only remains the most important function of this evening's proceedings, namely to induct my successor, Sir R. Douglas Powell.

The President then called upon Sir R. Douglas Powell to take the Chair, and invested him with the President's badge and master-key.

Sir R. Douglas Powell, who met with a hearty welcome, said: I am sure, Mr. Willett, it is quite impossible for me to adequately express my sense of the very high honour which has been conferred upon me to-day by my election to fill the Chair which you have occupied so admirably for the past two years in this Society. It is an honour which I shall ever esteem as the very highest which has ever come to me, and is ever likely to come to me, for it has been conferred upon me by my brethren in the profession. I need not say, sir, that I shall do my utmost to uphold the honour and traditions of this Society, and that, with the help of my colleagues in the Council and my friends in this Society, I shall endeavour to maintain its dignity in a manner worthy of those who have preceded me. I thank you very much.

The proceedings then terminated.

(A) Income and Expenditure Account for the Year ending 31st December, 1903.

Expenditure

	£	s.	d.	£	s.	d.
Rent, Rates, Taxes, and Insurance ...	226	5	7			
Salaries of Staff and Accountant ...	664	5	0			
House Servants, Cleaners, etc. ...	290	1	11			
Renumbering Books	52	0	0			
Lighting, Warming, and Cleaning ...	307	10	9			
Printing, Stationery, Stamps and Telegrams	200	15	8			
Meeting Expenses	33	13	6			
Miscellaneous Disbursements ...	134	13	2			
				1909	5	7
Repairs, Alterations, etc. ...				227	5	4
Depreciation of Fixtures, Fittings, etc.				52	13	0
Library Purchases and Expenses ...				517	4	6
Interest on Debentures				1018	19	7
Suspended Animation Committees ...				20	0	0
Lift Charges				39	18	0
Marshall Hall Brass				12	0	0
'Transactions'				517	14	3
Audit Fee				10	10	0
Balance, being excess of Income over Expenditure during the year (including Legacy of £300) ...				857	12	1
				£5183	2	4

Income

	£	s.	d.	£	s.	d.
454 *Annual Subscriptions at* £3 3s.	1430	2	0			
100 *do.* £1 1s.	105	0	0			
				1535	2	0
Composition Fees				82	19	0
Entrance Fees				110	5	0
Rents Receivable				3045	2	0
Sale of 'Transactions'				57	9	11
Interest on New South Wales Stock ...				12	10	3
**Legacy from Mr. E. N. Berry* ...				300	0	0
Miscellaneous Receipts				5	18	2
Fees for use of Epidiascope ...				33	16	0
				£5183	2	4

February, 1904.
W. S. CHURCH,
WARRINGTON HAWARD, } *Hon. Treasurers.*

Audited and approved,
TOM MUNDY, *F.C.A.*
February, 1904.

* This was applied in paying off £300 Debentures.

(B) STATEMENT OF LIABILITIES AND ASSETS, 31ST DECEMBER, 1903.

LIABILITIES.

	£	s.	d.
3 per Cent. First Mortgage Debentures . .	33,700	0	0
[The Debenture Debt has been reduced by £400 since the previous statement, by cash paid in respect to Debentures redeemed.]			
Sundry Creditors	1,164	13	4
Balance, being Surplus of Assets over Liabilities viz.—	28,968	8	3
Balance, 31st December, 1902 £28,110 16 2			
Excess of Income over Expenditure for the year 1903 . . . . . 857 12 1			
£28,968 8 3			
	£63,833	1	7

ASSETS.

		£	s.	d.
Freehold and Leasehold Property (as per last Statement)	£51,500 0 0			
Additions during year . .	84 0 0			
		51,584	0	0
Fixtures, Fittings, and Furniture	1,053 0 9			
Less 5 per cent. written off for depreciation . . .	52 13 0			
		1,000	7	9
Engravings . . . . (as per Valuation of Mr. F. B. Daniell, Aug. 19, 1896).		555	0	0
Contents of Library (as per Balance-sheet, Dec. 31, 1901)		8,792	14	7
Stock of 'Climates and Baths' .		320	15	9
Investment—"Permanent Endowment Fund" . . . (New South Wales 4 per Cent. Inscribed Stock).		326	7	3
Sundry Debtors for Rents and Outstanding Subscriptions .		826	3	3
Cash at Bank and in hand .		427	13	0
		£63,833	1	7

February, 1904.

W. S. CHURCH,
WARRINGTON HAWARD, } *Hon. Treasurers.*

Audited and approved,

TOM MUNDY, *F.C.A.*
February, 1904.

LIST OF PAPERS.

N.B.—The Council of the Royal Medical and Chirurgical Society deem it proper to state that the Society does not hold itself in any way responsible for the statements, reasonings, or opinions set forth in the various papers which, on grounds of general merit, are thought worthy of being published in the *Transactions*.

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II. Remarks on Fifty Consecutive Cases of Perforated Gastric and Duodenal Ulcer treated by Laparotomy; by T. CRISP ENGLISH, M.B.Lond., F.R.C.S.Eng., Hunterian Professor, Royal College of Surgeons, England; Assistant Surgeon, Grosvenor Hospital for Women and Children; Surgical Registrar, St. George's Hospital . . 27

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V. On Hour-glass Stomach; by B. G. A. MOYNIHAN, M.S., F.R.C.S. 143

VI. Observations on Metabolism in the Febrile State in Man; by G. C. GARRATT, M.D.Cantab., late Assistant Resident Medical Officer at the London Fever Hospital 163

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VII. The Cardiac Dulness in Cases of Cancer; by W. Gordon, M.D., F.R.C.P., Physician to the Royal Devon and Exeter Hospital; Physician to the West of England Eye Infirmary 327

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IX. The Mental Condition in Epilepsy in Relation to Prognosis; by William Aldren Turner, M.D., F.R.C.P., Physician to Out-patients at the National Hospital for the Paralysed and Epileptic, Queen Square, and at King's College, Hospital; and Visiting Physician, the Colony for Epileptics, Chalfont-St.-Peter 349

X. The Economic Value of the Sanatorium Treatment for the Working Classes, based upon After-histories; by Noel Dean Bardswell, M.D., M.R.C.P., F.R.S.Edin., and John E. Chapman, M.R.C.S., L.R.C.P., Physicians to Mundesley Sanatorium . . 373

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XII. Anæmia Pseudo-leukæmica Infantum; by J. H. Drysdale, M.D.Cantab., F.R.C.P.Lond., and Hugh Thursfield, M.D.Oxon., M.R.C.P.Lond. . 451

XIII. Leucocyte Counts in Eighty-three Cases of Appendicitis: the Limitations of Leucocytosis as an indication for Laparotomy; by Herbert French, M.A., M.D.Oxon., M.R.C.P.Lond., Medical Registrar, Guy's Hospital; Gillson Scholar, Society of Apothecaries of London; Radcliffe Travelling Fellow, Oxford University 467

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ADDRESS

OF

ALFRED WILLETT

PRESIDENT

AT THE

ANNUAL MEETING, MARCH 1ST, 1904

ALTHOUGH in the Society's external relations the events of the past year do not call for any special comment, nevertheless the Society's record of work accomplished in the period under review is fully as interesting as that of any of its predecessors in recent years. The observations on passing events which I have now, in accordance with custom, to submit to the Fellows will, I think, prove in the first place that the Society, in spite of the falling in of the Berners Street lease at the end of the current year, is in a very satisfactory financial position, and in the next that it is steadfastly endeavouring to advance its sphere of usefulness to the Fellows and to the profession.

The Treasurers' statement does not appear in need of any support on the present occasion. It exhibits the very satisfactory feature of a balance of £857 on the right side.

The Honorary Librarians' report is especially interesting, evidencing, as it does, on the one hand, the great value the library is to the Fellows and, on the other, the great effort the Society is continuously making to maintain this most important department in the utmost efficiency.

Owing to Mr. Berry's generous legacy, the Council felt that it could at last confer upon the users of the library a long-desired boon, viz., an up-to-date card catalogue of the entire contents of the library. This work is in hand, and will shortly be placed in the library. A card catalogue makes it possible to keep up the daily additions to the library in such a way that the whole contents of the library will be displayed at once under one alphabet, instead of having to be searched for in different places, as at present.

In addition to this, the opportunity is being taken of re-arranging the entire shelf notation of the library, which the removal from Berners Street had dislocated. This will make it as easy for Fellows using the library to find the books on the shelves as for the members of the staff, and will generally greatly facilitate the service of the library.

Within the last fortnight, the Council has made an arrangement with one of our tenants for the retrocession to the Society of the room at one time the electric accumulator room. This room, when shelved, will form a valuable and much-needed adjunct to the library, since it will hold at least six thousand volumes.

The report of the Committee on "Suspended Animation in the Drowned" was communicated to the Society by its Chairman, Professor Schäfer, on May 26th, 1903, before a large audience, many of whom, representing societies and public bodies interested in this question, had been specially invited by the Council to be present. This report, with all its numerous illustrations, is being issued as an independent volume, following the precedent in similar instances of scientific reports.

The Society owes a heavy debt of gratitude to Professor Schäfer and his colleagues for this most valuable report, but

especially to Professor Schäfer personally for the large amount of new evidence which his laborious investigations have brought to bear on the question. A subsidiary paper entitled "A Description of a Simple and Efficient Method of Performing Artificial Respiration in the Human Subject, especially in cases of Drowning," to which is appended instructions for the treatment of the apparently drowned, was read at one of the ordinary meetings of the Society on December 8th, and is incorporated in the 'Transactions.'

The Society at a special meeting—duly convened by the Council on June 9th, 1903—instituted a new order of Fellowship of the Society, having for its object the admission to the Society of Officers in the Naval, Military, and Indian Medical Services on specially favourable terms. The name of "Service Fellows" has been given to this order of Fellowship. No one can, I am sure, question the great desirability of bringing together under the ægis of the Society, the Combatant and Civil members of our common profession. The establishment of the Military School of Medicine in London seemed to offer the occasion for this new departure. I am pleased to add that this invitation to our combatant brethren has the hearty support and encouragement of the heads of the respective medical services. The Director-General of the Army Medical Department, Sir William Taylor, has himself joined the Society as a Service Fellow.

I may here mention that the Bye-laws and Standing Orders have been completely revised, edited, and brought up to date. For this most important work, requiring a very thorough knowledge of the Society's inner life, we are indebted to Mr. Dent more than to any other individual. It is, however, only a single instance of the most valuable service Mr. Dent has rendered the Society during his tenure of office as Surgical Secretary and makes everyone regret that it has come to a close.

The Royal Medical and Chirurgical Society of London was represented at the International Medical Congress held at Madrid in April, 1903, by Sir Dyce Duckworth,

one of the Vice-Presidents. In the very ample report of the proceedings which Sir Dyce made to the Council, he criticised with some severity, but obviously most justly, the utter want of forethought by the local authorities in organising the arrangements necessary for the successful conduct of the business of the Congress. The next Congress will be held in 1905 at Lisbon.

You will have noted the Council's report alludes to the brass tablet which has been placed in this—the Society's meeting room. The names of the distinguished men to whom at intervals of five years the Memorial Prize has been awarded are engraved on it. Its presence on our walls will serve to keep in evidence the revered and honoured name of Marshall Hall, whilst it is hoped that the names of the distinguished men engraved on it will encourage workers in neurology to emulate their fame. I may mention in connection with this subject that Dr. Head, to whom you will recollect the prize was presented at the last Annual Meeting, will shortly deliver an address before the Society on his recent investigations.

A similar tablet has been ordered to be placed in a corresponding position. On this memorial tablet the names of generous donors to the Society's funds will be recorded.

At the last Annual Meeting I drew attention to the near approach of the Society's Centenary, the actual date of which will fall on Monday, May 22nd, 1905. At the instance of the Council, a provisional programme has been drawn up for celebrating the event. Upon my successor and upon the new Council will devolve the duty of now taking the matter in hand. In view, however, of the festivities likely to occur on that occasion, the Council decided that the biennial dinner which under ordinary circumstances would have been held this year should not take place.

I have already alluded to Professor Schäfer's communication as the event of the year in the Society's ordinary life, but I hasten to add that all the papers read before

the Society have been of a high standard of excellence, and worthy of its best traditions. I venture to affirm that all have shown evidence of good work either in the field of active professional life, or in the domain of patient investigation of pathological processes or problems; all alike have been characterised by an earnest longing after knowledge, and by the nobler longing to combat the processes of disease more successfully; but with regret I add that the attendance has again fallen far short of that which the importance and interest of the subjects dealt with in the papers justified us in expecting, and, if I may be pardoned the remark, such scanty attendance appears to be a poor acknowledgment for all the time and trouble taken by the authors in preparing their communications. In a thin meeting discussion must languish, and without adequate discussion the best of papers seem to miss their point. Although the number of Fellows has been considerably augmented, yet speaking from recollection, I should say the attendance at meetings is far smaller than it was thirty to forty years ago. "Tempora mutantur et nos in illis mutamus." In this truth I believe lies the explanation. Small wonder is it that with an eight o'clock dinner hour, with the rival attractions of a multitude of theatres, and social entertainments of one kind and another, the allegiance of the Fellows is diverted from the Society's evening meetings.

In venturing to offer some suggestions to cope with this state of affairs, I wish to make it quite clear that I am giving expression to my own personal views only, and that I am not the mouthpiece of the Council or of any other individual, and I go farther, for it appears to me that the advisability of altering the time of our ordinary meetings from the evening to the late afternoon, with the object of suiting the greater convenience of the Fellows, is a question that should originate with the Fellows, and that the Council could only deal with it after receiving a requisition from them.

This is not the occasion to elaborate arguments, but I

may point out that our evening meetings occupy one hour and a half, *i. e.* from 8.30 until 10 p.m., so that a meeting at 5 p.m. or even 5.30, would be well over at 7 to 7.30. The number of meetings in each session are about fourteen or fifteen, and are held once a fortnight in the winter and spring months. The library is usually fairly well filled at this time, evidencing that it is convenient to the Fellows to come here in the afternoon, whilst our Annual Meeting, the Council and all Committee meetings are held at this time. Some consideration might also be given to a very natural disinclination in some households to alter the domestic arrangements as to the dinner hour and also as to turning out after dinner on a cold and foggy, or wet and miserable evening.

We all miss at to-day's proceedings our energetic Secretary, Mr. MacAlister. You will be very sorry to hear that he is somewhat out of health, and has been medically ordered to go abroad to recuperate. The Council have readily, although regretfully, acceded to his request for three months' leave of absence; of course adequate arrangements have been made for carrying on the Society's affairs for this period. I believe from all I have heard that there is every reason to anticipate Mr. MacAlister will in due course be back amongst us completely restored to health.

On the present occasion I have but fourteen deaths amongst our Fellows to record, whereas last year the number was twenty-four.

Within the last few days, and indeed since I wrote these words, yet another notable Fellow has passed away in the person of Sir Edward Sieveking, one of the past Presidents, at a very advanced age. I think he was 88.

Sir Edward Sieveking's Presidency should be always held in grateful remembrance by the Fellows, for during his tenure of office it was that the great historical event of the purchase of this house for the purposes of the Society occurred. This association may in time be forgotten, but the President's Badge of office was the gift of Sir

Edward Sieveking, and by it the donor's name will be handed down from generation to generation.

There has not been time since Sir Edward Sieveking's death to collect and put together for an obituary memoir the notable events of his life and work, hence this duty I must leave to my successor.

Of our deceased Fellows Mr. Image had reached the very advanced age of 96, another, Dr. Lloyd Birkett, was in his 90th year, whilst the name of the youngest Fellow to be cut off by death was Mr. Charles Cosens, at the age of 43.

I will now relate such particulars of the Fellows, whose deaths I have to announce, as I have been able to obtain, and I wish in this place to express my sincere thanks to all who have so readily placed information at my disposal.

John McIntyre, M.D., LL.D., died on February 6th, 1903, at Odiham, Hants, in his 84th year.

He was elected a Fellow in 1859.

Educated for the profession at Glasgow, he took the degree of M.D. St. Andrews in 1839. He was also L.R.C.S.Edin., 1839, and L.S.A.Lond., 1841, whilst in 1889 he received the honorary degree of LL.D. of the University of Glasgow.

Dr. McIntyre had retired from practice for upwards of a quarter of a century, and I regret it has not been possible to obtain particulars of his professional career.

Dr. McIntyre was a very wealthy man—presumably he had inherited a fortune. His personal estate amounted to over £150,000. By his liberality a Students' Union was added to Glasgow University, and he bequeathed £1000 each to the British Medical Benevolent Fund, the Royal Medical Benevolent College Pensioners' Fund, and for a cottage hospital at Odiham.

William Henry Crosse, M.D.Durh., M.R.C.S.Eng., L.F.P.S.Glas., L.S.A., late Principal Medical Officer Royal

Niger Company, died on February 24th, 1903, at the age of 44, at his residence, 37, Albemarle Street, W., after many years of feeble health, induced by a service of nine years on the West Coast of Africa. An enormously hypertrophied spleen and persistent œdema of both legs formed two of the serious troubles which for many years had made him a valetudinarian.

Dr. Crosse became a Fellow in 1899, but had not contributed to the Society's 'Transactions.'

Dr. Crosse was the son of the Rev. Marlborough Crosse, and was born in 1858 in Norfolk. He studied medicine at Guy's Hospital Medical School, which he joined in 1876. He became L.S.A. in 1880, L.F.P.S.Glas. 1881, M.R.C.S.Eng. 1886, and M.D.Durh. 1900. In addition to his Fellowship of this Society, he was also F.R.G.S.

After a few years' practice in the Isle of Dogs, where he succeeded in establishing a very large connection, Dr. Crosse joined the Royal Niger Company's service in 1886, and spent nine years on the West Coast of Africa, only to return in broken health. Nevertheless he practised in London until his death, being retained by the Royal Niger Company as its London medical adviser.

Dr. Crosse was a man of indomitable pluck, determination, and energy, and wherever he might be located, or whatever the duty with which he was entrusted, at once his vigorous personality asserted itself, forcing him to take the position of a leader, and a leader who was readily followed.

Dr. Thomas John Maclagan, Physician in Ordinary to their R.H. the Prince and Princess Christian of Schleswig-Holstein, died on March 20th, 1903, at his residence, 9, Cadogan Place, at the age of 65. As a physician Dr. Maclagan was well known, and few enjoyed the confidence of his patients more completely. He passed away in the zenith of a career of professional activity, for he had only become so seriously unwell as to compel him to give up work a few weeks before the fatal issue of his illness.

His death was caused by cancer of the stomach, and although an exploratory operation was undertaken in the faint hope that it might be found possible to remove the involved structures, this result was found to be impracticable owing to the extent of the disease; a gastro-enterostomy was performed, and this gave relief to his more distressing symptoms.

Dr. Maclagan was elected a Fellow of the Society in 1879, but did not contribute to its 'Transactions' or hold office. He was nominated for the Council, but press of work compelled him to ask to be excused.

Thomas John Maclagan was the son of another Thomas Maclagan who, after a very successful career as a medical man in Jamaica, retired to Scone, in Perthshire. He received his early education at a school in Perth, studied the "humanities" at Glasgow University, and afterwards went to Edinburgh to take up medicine. There he obtained the M.D. degree in 1860, and then spent some time in further study at the schools of medicine of Paris, Munich, and Vienna.

The late Dr. Maclagan's early professional life was passed in Dundee. He came to London in 1879, and quickly rose, acquiring a very large and fashionable practice. The subject of rheumatism had early engaged his attention; an article on the treatment of rheumatic fever by salicin in 1876 attracted professional attention. In 1881 he further developed his views in a monograph entitled 'Rheumatism: its Nature, Pathology, and Successful Treatment,' of which a second edition was published in 1896. In this he gave with much detail his reasons for rejecting the neurotic and lactic acid theories of rheumatic fever, and urged that it must be due to the life processes of a parasite having its special nidus in muscles and the fibrous tissue of the joints and heart. According to him, rheumatic fever is in essence an intermittent fever, of which the intermittences are obscured by the cycles of existence of the parasites in various foci not being coincident. In the administration of salicin he

insisted on the close repetition of large doses until pain subsided and temperature became normal.

Dr. Maclagan was a keen sportsman, and yearly spent his autumnal holiday on the moors of Scotland. He would walk hard all day after grouse, appearing never to feel fatigue; moreover, he was a delightful companion.

One who knew him well says: "In describing Dr. Maclagan's characteristics, I would say that they gave evidence of a high sense of honour, a great love for his work, and intense self-reliance, which won for him from his patients an absolute confidence such as is seldom seen."

Dr. Edmund Lloyd Birkett, who for many years practised as a consulting physician in Russell Square, W.C., died on May 8th, 1903, at the Rectory, Westbourne, near Emsworth, Sussex, the residence of his elder son, the Rev. C. B. Birkett, in his 90th year.

Dr. Birkett was elected a Fellow of the Society in 1849; he held office as Member of the Council, and did the Society good service as Referee of Papers, but he did not himself contribute to our 'Transactions.'

Dr. E. Lloyd Birkett was the youngest son of Mr. John Birkett, a solicitor of Cloak Lane, E.C., and was educated at Eton, to which school it is said he was sent at the age of eight, and only leaving it when nineteen; then he went to Cambridge, and, being destined for the medical profession, entered at Caius College. After taking his B.A. degree he studied medicine at Guy's Hospital. He passed the M.B. examination at Cambridge in 1838, and took the M.D. in 1847. Continuing for a time at Guy's, he was appointed Curator of the Museum, and joint Editor of the 'Guy's Hospital Reports.' Dr. Birkett was elected F.R.C.P. in 1848, and subsequently was appointed by the College of Physicians, Censor, an Examiner in Medicine, and finally one of its Vice-Presidents.

The City of London Hospital for Diseases of the Chest was established in 1848. Dr. Birkett became Physician to it, and held office for a long term. Upon his resignation

he was made Consulting Physician. On retiring from practice in 1890, he went to live with his son at Westbourne Rectory, and notwithstanding his great age he retained his intellectual faculties till the close of life, taking a keen interest in all contemporary questions. He was spare in figure and of active habits. His general health remained good until an attack of influenza prostrated him in November, 1902.

Dr. Birkett was a fine classical scholar, and he was a quiet, conscientious gentleman; it is said that he would have made a greater position had he chosen the church rather than medicine as a career, for throughout life religious and theological questions strongly attracted him.

Dr. Birkett married in 1850 the only daughter of Mr. B. E. Battley; two sons, both in the church, and a daughter survive him.

Alfred Haviland, so widely known as one of the pioneers in the study of Medical Geography, died on May 30th, 1903, at "Ridgemount," Frimley Green, Surrey, in his 79th year, after a lengthened illness.

Mr. Haviland was elected a Fellow of the Society in 1854; he had not, however, taken any part in its affairs.

Mr. Haviland was born at Bridgwater, Somersetshire, in 1824, his father being the late Mr. James Haviland, J.P., M.R.C.S.Eng., who had long practised in that town.

Alfred Haviland's early education was received at the Hackney Church of England School, and after leaving school he became a student of University College Medical School. Qualifying in 1845, he joined his father in practice. Four years later Bridgwater was one of the towns attacked by the cholera epidemic of 1849, and the younger Haviland was placed in charge of the cholera patients. Whilst so engaged he made meteorological observations day and night, and noted the following coincident facts: "(1) Whenever well-established 'calms' prevailed over the infected area there was at once an increase in the number of fresh cases of cholera; and (2) on the other

hand, whenever the air was disturbed by equatorial currents from south to west, blowing strongly, the number of fresh cases of cholera was immediately reduced."

A few years later he had an attack of blood-poisoning from an infected wound. This illness nearly cost him his life, and it led to his relinquishing the active practice of his profession, and from this time onwards, incited, doubtless, by his investigations of the recent epidemic of cholera, he devoted his life's work to meteorological influences on epidemics and the geographical distribution of disease, on which subjects he became a prolific writer. It was during his convalescence and enforced inactivity that he made his first map of the distribution of rheumatism and heart disease, with graduated colours of red and blue. To supply a demand copies were published, and very soon followed maps of "cancer" and "phthisis" on the same lines. From early in life Mr. Haviland made the geography and causes of disease his study, and he read everything connected with the subject up to the last, taking the greatest interest in this work. Before having to give up active professional work he was Surgeon on the honorary medical staff of the Bridgwater Infirmary, Honorary Lecturer at St. Thomas's Hospital Medical School on the "Geographical Distribution of Disease," and Medical Officer of Health of the Northampton combined districts.

The year 1848 is memorable among meteorologists from the fact that Schönbein then first made known his discovery of how to detect ozone in the atmosphere by means of white blotting-paper saturated with a solution of potassium iodide and starch. To England during 1853 these papers were brought, a corps of observers was formed, and he was among the first to join at the request of his friend, the late Mr. G. J. Symons, F.R.S., and he has mentioned the deep impression some of the results of his observations made upon him, for he very soon found that the "calms" and "strong equatorial winds," which he had noted in 1849, when tested by the ozone papers, produced

widely different effects on them, for during "calms" the little white slip of paper would hang for days without indicating any ozone in the air, whilst, on the other hand, immediately the wind blew strongly from the southerly quarters, it would assume a dark brown colour, and when immersed in water change to a beautiful dark violet hue.

In 1856, with a view to bringing before his brother medical practitioners an epitome of the observations of Hippocrates, he published his first work on 'Climate, Weather, and Disease,' in which, among other subjects, the mortality from phthisis in relation to atmospheric temperature was considered. This led to a correspondence with the eminent French physician and medical geographer, Boudin, who shortly after published his 'Géographie Médicale,' based principally on the statistics of the French army. At that time Dr. Farr had not published his first supplement to the Registrar-General's reports, and therefore a medical geography for England and Wales would have been a difficult if not an impossible task.

In 1864 Dr. Farr published his first decennial supplement to the Registrar-General's Twenty-fifth Annual Report, which rendered the geographical distribution of disease in England and Wales a possibility. This supplement afterwards formed the basis of the first edition of Mr. Haviland's work on 'The Geographical Distribution of Disease.'

At the late Dr. Robert Druitt's request he wrote an article calling attention to the folly of hurrying to catch trains, which article was published in the 'Medical Times and Gazette' on February 22nd, 1868, under the heading of "Hurried to Death," and was reprinted in pamphlet form with considerable additions in the autumn of the same year under the same title.

It was in this reprint that Mr. Haviland first gave the results of his investigations into the "Geographical Distribution of Heart Disease," having undertaken to test the soundness of the prevailing opinion that the new

mode of travelling by railway was the cause of the supposed increase of that cause of death.

On consulting Dr. Farr's first supplement to the Registrar-General's Twenty-fifth Annual Report for the ten years 1851-1860 he tabulated the death-rate so as to enable him to devote a chapter (pp. 42-49) to "The Geographical Distributions of Heart Disease in England and Wales," in which he foreshadowed the results he afterwards published in a paper read before the Medical Society of London. In this preliminary chapter he gave a diagram roughly showing the mortality from heart disease according to aspect throughout the country. His next attempt at illustrating the subject was by mapping out the 630 registration districts of England and Wales in colours, which work was very greatly facilitated by the kindness of the late Major Graham, the then Registrar-General, the late Dr. Farr, and Captain William Clode.

On November 30th, 1868, Mr. Haviland read his first paper on the "Geographical Distribution of Cancer among Females throughout England and Wales during the Decennial Period 1851-1860" before the Medical Society of London.

In 1875 he published 'The Geographical Distribution of Heart Disease and Dropsy, Cancer in Females, and Phthisis in Females in England and Wales,' illustrated by coloured maps.

In 1876 he published a report on an outbreak of enteric fever in Uppingham School, 1875-1876.

In 1879 he read a paper entitled "The Distribution of Disease popularly considered," for which he received the "Society of Arts" Silver Medal.

In 1879 he read a paper entitled "Geology in Relation to Sanitary Science" at the Croydon Congress of the Sanitary Institute, and in 1882 published 'Brighton as a Health Resort.'

The following year (1883) his works, 'Scarborough as a Health Resort' and 'Consumption in the Isle of Man,' illustrated by coloured maps, came before the public.

In 1886-1887 he brought out maps and papers on "Wheat Yield" "Glaciation," and "Sunshine" in the Isle of Man.

In 1888 he brought forward his views in "Chalk *v.* Cancer" at the International Geological Congress. He also established the Manx Geological Society, of which he was the first president.

The next year (1889) the pamphlet on 'The Infrequency of Cancer in the Lake District' was published.

In 1890 "The Increase of Cancer; its Probable Cause," was published in the 'Lancet.' "The Ill Effects of Floods on Health" was read before the Congress of the Sanitary Institute held at Brighton.

In 1891 a paper on "The Influence of Clays and Limestones on Medical Geography, illustrated by the Geographical Distribution of Cancer among Females in England and Wales," was read before the Hygienic Congress; also "Climates, Past and Present," "Port St. Mary as a Health Resort," and various papers on the Isle of Man were written in this year.

The year 1892 saw the second edition of 'The Geographical Distribution of Disease in Great Britain' published, the English lake district being specially dealt with.

In 1896 an address entitled "Medical Geography as an Aid to Clinical Medicine" was delivered by him at the first meeting of the Isle of Man Medical Society.

Mr. Haviland had been almost incapacitated for work since November, 1900, but prior to that period he had collected various material for Part II of his work, which up to the last he looked forward to publishing.

Mr. Haviland came of an old Norman family, a branch of which had been settled for several generations in Somersetshire, whilst his mother was a lineal descendant of one of the oldest families in Devonshire—the Haydons, of Cadhay. He married a daughter of the late Mr. Edward Pain, of "Wykeham Park," Frimley, who survives him, and

leaves a son, Mr. Charles Cobleigh Haviland, and a daughter, Miss Louisa Philippa Bellew Haviland.

In view of the loss to medical science by Mr. Haviland's death, a restatement of his main conclusions is appropriate.

He investigated the incidence of mortality from certain definite causes in the 630 registration districts of England and Wales. He arrived at the conclusion that "the fields of the deadliest struggles with either cancer, phthisis, or heart disease in the 1861-1870 campaign are identical in the majority of cases with those marked in the map for 1851-1860, and that the least deadly fields of the earlier corresponded with those of the later decenniads." Having established by his statistics that for twenty years certain districts had an excessive mortality from the above diseases, Mr. Haviland announced as the result of his climatological and geographical study of these districts :— (*a*) That cancer was more fatal among women in clayey, flooded areas than on elevated calcareous soils ; (*b*) that heart disease and rheumatism were more fatal in the unventilated valley-system of England and Wales than in the open areas freely exposed to the prevailing winds and sunshine ; and (*c*) that those tainted with phthisis succumbed readily to the full blast of prevailing winds.

John Charles Galton, M.A.Oxon., M.R.C.S.Eng., died on June 14th, 1903, at his residence in Upper Cheyne Row, Chelsea, aged 63.

Mr. Galton had seen much of military medicine and surgery ; he spent many years in the military service of foreign nations ; during the Franco-German War he was a staff-surgeon in the Hessian division of the German Army, and subsequently was placed in charge of the Princess Alice Hospital at Darmstadt. He served throughout the second expedition to Atchin, having joined the Dutch East Indian Service, whilst in 1876 he went out as a surgeon of the National Society for Aid to the Sick and Wounded in the Turko-Servian War.

Mr. Galton was elected a Fellow of this Society in 1883.

He was the eldest son of the late Rev. J. L. Galton, of Exeter, and was educated at Rugby and Magdalen College Schools; he entered Exeter College, Oxford, and after obtaining his B.A. degree he joined the Medical School of St. Bartholomew's Hospital in London. He passed the M.R.C.S.Eng. in 1866, and subsequently studied in Vienna, and for a time held the lectureship on Comparative Anatomy at Charing Cross Medical School.

Mr. Galton was a Fellow of the Linnæan and Zoological Societies; he contributed several articles on scientific as well as medical subjects from time to time, and translated some German medical works into English. His talents were of a high order, whilst his personal character and affectionate disposition endeared him to all who knew him.

William Cadge, F.R.C.S.Eng., lovingly known over a wide area by a large professional circle as "Cadge of Norwich," died at Lowestoft on June 25th, 1903, in his 81st year, after a long illness. Mr. Cadge achieved an unique position, for, whilst he was regarded as one of the most distinguished British surgeons of his time, especially renowned for his operative dexterity in cases of vesical calculus, he was equally distinguished as a philanthropist and benevolent citizen of Norwich, in which city he had resided for upwards of fifty years.

Mr. Cadge was elected a Fellow of this Society in 1851, and in 1854 he contributed a paper "On Dislocation of the Femur upwards and forwards beneath the Crural Arch." In it he recorded the condition found upon dissection in a case of unreduced dislocation of sixteen years' standing. A very serviceable "false joint" was found, a new and complete acetabulum "being formed so complete as to hold the thigh bone suspended after all the soft parts were removed, and make it requisite to saw off a large piece of the new bone in order to set the femur at liberty." In other respects the reparative process had brought about a remarkable approach to the normal conditions of a healthy hip-joint, even to the production of a new ligamentum

teres. Mr. Cadge drew attention to the fact that his case did not come "under any one of the four classified forms of dislocation of the thigh as given by Sir Astley Cooper," remarking that whilst Sir Astley's classification had a general correctness, the femur nevertheless "admits of displacement in almost every direction." Lastly, he compared other recorded cases of the same injury, and points out that their "diagnostic signs" are "more or less shortening of the limb, eversion of the toes, and the presence of the globular head of the femur in the groin."

Mr. Cadge's very active professional life is in all probability responsible for the fact that he did not contribute further to the Society's 'Transactions.'

Mr. Cadge, who came of a well-known yeoman family in Norfolk, commenced his medical career as a pupil of Mr. Taylor, of Kingston-on-Thames (father of Professor Sedley Taylor, of Trinity College, Cambridge). In London he went to University College Hospital, when Robert Liston was at the height of his reputation as an operating surgeon. Mr. Cadge passed the College of Surgeons in 1845, and then became Liston's private assistant, and remained with him till his death in 1847, when Mr. Cadge contributed an account of his last illness and of the post-mortem examination to the 'Lancet.' He then became Demonstrator of Anatomy in University College, and assisted Morton in producing his anatomical plates. In 1848 he became Fellow of the College of Surgeons by examination, and in 1850 he was appointed Assistant Surgeon of University College Hospital, succeeding the late Sir John Erichsen, who had been promoted to the post of surgeon.

Sir Henry Thompson has most kindly sent me his reminiscences of Cadge's London career. Sir Henry states: "I was a student at University College in the year 1845, when Cadge was house surgeon, and used to sit at his side with other students when he saw the out-patients. He was there when Liston was there, and assisted at the first operation under ether which took place in an extemporised

apparatus made by old Squire, the well-known chemist and druggist, and father of the present family, who had received an account of it from New York. He was rather closely connected with Liston's work, and was his favourite assistant, I think, in his operations. I may say by the way that Liston was the only man among the whole staff to whom I had a personal introduction. I called upon him at his house, 5, Clifford Street, Bond Street, and received a hearty reception, and never pass the house now without remembering the interview. Poor fellow, he died soon afterwards, and Cadge among others with myself, 'inter' many other students attended the funeral. Soon after that Cadge left for Norwich."

Shortly after coming to Norwich Mr. Cadge was appointed Assistant Surgeon to the Norfolk and Norwich Hospital; in due course he became Surgeon. In the days of his prime the operating room at the hospital was often crowded by country surgeons, who came to see him operate, it being universally recognised that as an operating surgeon he was probably unequalled. Patients came from all parts of the kingdom, and even from abroad, to be under his care for the speciality for which he was so celebrated—stone in the bladder. The museum at the Norfolk and Norwich Hospital gives abundant evidence of his skill in this department. He was one of the first of leading provincial surgeons to adopt the antiseptic system.

Mr. Cadge was a great surgeon. As a consultant he commanded the absolute confidence of the entire profession in East Anglia. As a general practitioner (which for the greater part of his career he considered himself) Mr. Cadge was equally distinguished. There could be no medical man in whom his patients had more unqualified confidence and affectionate esteem.

Mr. Cadge was a good citizen, and, notwithstanding his avoidance of municipal and magisterial duties, he accepted without hesitation the office of representing his Sovereign, and his shrievalty was marked by unostentatious dignity and hospitality, whilst his philanthropy was evidenced by

his noble contribution of £20,000 to the Norfolk and Norwich Hospital. To benevolent associations connected with the medical profession Mr. Cadge was ever a large contributor, and many a needy medical man has had cause to bless his large-hearted and often anonymous liberality. William Cadge was steadfast in his friendships; his sound judgment, his deliberative, almost judicial mind caused him to be frequently consulted by those in trouble or difficulty, and never in vain.

But for Mr. Cadge, the new Norfolk and Norwich Hospital would probably not have been built. Having satisfied himself that the old hospital had lived beyond its natural life, and from its insanitary condition was no longer safe for the treatment of surgical patients, Mr. Cadge did not hesitate, in spite of great opposition and innumerable obstacles, to declare himself in favour of an absolutely new and up-to-date hospital. It was uphill and arduous work, as all those who took part in the discussions, often heated and prolonged, will remember; but Mr. Cadge finally triumphed, and the result is the present beautiful and well-planned hospital.

He was elected a Member of the Council of the College of Surgeons of England in 1880, and held office for sixteen years. He was Hunterian Professor of Surgery in the College in 1886, when he took for the subject of his lectures, "Lithotomy and Lithotrity," operations on which he could speak with the authority of a master. These lectures, which embodied the result of his vast experience, were afterwards published. He delivered the address in surgery at the annual meeting of the British Medical Association held at Norwich in 1874.

On the Council of the College of Surgeons, Mr. Cadge always held an influential position, and although a "country member" he took his full share of work on committees. He declined the honour of the vice-presidency. He did not intervene very frequently in discussions, but whenever he spoke he was listened to with marked attention; his shrewd innate sense of what was the right course

to adopt and where in disputed statements the truth lay made him an earnest and impressive speaker, whilst his dignified manner and transparent honesty seemed to add a conviction that the causes he espoused or the opinions he expressed were just.

One who was an almost life-long friend of our deceased Fellow writes of him thus: "Cadge was endowed with a masculine understanding of great power and versatility. Though before entering on the study of his profession he had received but a scanty general education, he subsequently acquired for himself the power of writing excellent, tersely-worded English, and of taking part in oral discussion on fully equal terms with men who had enjoyed far higher educational advantages than had fallen to his lot. I was constantly impressed, especially when we discussed subjects of which my experience happened to have been greater than his, by the alacrity of mind with which he would pounce on a weak argument—the only weak thing to which he ever applied such treatment—or make a telling use of facts with which he had only just before become acquainted. His dominant intellectual characteristic was, I think, the desire to arrive at truth; and whatever he had recognised as incompatible with it he promptly consigned to the mental wastepaper basket. At the same time he extended a wide liberality to men whose convictions were opposed to his own. On one occasion this liberality, exercised by asking to dinner an old fellow student who had become a homœopath, brought on him a letter of remonstrance from a brother practitioner who had got wind of this unprofessional behaviour. 'I must be allowed,' was Cadge's reply, 'to retain the right of inviting to my table whom I please.'"

Mr. Cadge married a sister of the late Sir Richard Quain, but had no family. His wife predeceased him by many years. He was one of the few men who have enjoyed the privileges of reading an obituary notice of himself in the 'Times.' At the end of 1899 he had a severe attack of influenza with pulmonary complications, and a premature

announcement of his death led to a laudatory account of his career being published. The perusal of the notice amused and pleased Mr. Cadge, but the joke began to pall when wreaths from sympathetic admirers poured in from all sides. He did not, like Mark Twain in similar circumstances, write to the papers to say that the report was greatly exaggerated. Happily an authoritative contradiction quickly turned the mourning of his friends into joy.

Charles Henry Cosens, late of Oxford Terrace, Hyde Park, died on June 28th at Brockenhurst, Hants, in his 44th year. He was elected a Fellow of the Society in 1899, but had not contributed to its 'Transactions.'

He was educated at Kensington Grammar School and later on privately at Brighton, and was also for a short time at a naval school. As a young man he and an old school-fellow started in life in Scotland as farmers, but at the end of the year he went into the office of his father, the well-known port wine importer. Finding desk work irksome and uninteresting, he went to Spain and worked in the vineyards and Bodegas at Xeres. Whilst there he met with an accident to his leg which led to an entire change in his life. Periostitis of the femur followed the injury, and after a long illness he was brought back to England, placed under the care of Sir Thomas Smith, and ultimately the necrosed bone was removed. After nearly two years spent more or less on his back he recovered, although he was obliged to keep a drainage tube in the wound for some years, even during his hospital career.

It was while he was laid up that his interest in surgery began, for Sir Thomas Smith once laughingly proposed that, as he was so much interested in the operation and in his own case, he should enter St. Bartholomew's, and added that possibly he might even become his house surgeon.

Cosens took to the idea, entered the hospital in 1883, and his early aspirations were realised, for in October, 1889, he did become House Surgeon to Sir Thomas. He worked very hard as a student, seldom or never taking a

holiday, and living at the time at Kensington with his father, with whom he was often up most of the night. He could not live in college to be near his work on account of the bad health of his father, who was suffering from distressing attacks of angina pectoris. He worked best late at night, and only allowed himself a few minutes at table to take a small piece of meat and bread. Alcohol he always disliked, and his tastes were most simple. It was characteristic of him to grudge the time spent at meals.

Mechanical engineering, especially naval engineering, carpentry (which he learned thoroughly), photography in all its branches, including colour photography and microphotography, and all kinds of applied science, were his favourite interests and hobbies. So excellent and proficient was Cosens in all the technical details of microphotography that many authors are indebted to him for illustrations in their books. Dickens was his favourite author—he could quote many of his favourite passages word for word, and could always correct a quotation, or put anyone reading to him right if they hesitated a minute.

He had a great tenderness for animals and even insects, much disliking to take the life of the meanest.

He was a very fair shot, and at one time very fond of fishing, but the pleasure of these sports was to him much marred by his hatred of killing things.

In manner he was quiet and reserved. His really intimate friends were few in number, for he was not a man who sought friendship. But the few who were privileged to know him well held him in great esteem for his force of character, his amiability, and, above all, for his dislike of humbug, a vice which he especially detested.

Any thought of staying on for another year at St. Bartholomew's and becoming House Physician to Sir William Church was put an end to by his marriage, which took place in 1890. Then he joined Dr. Cripps Lawrence, with whom he worked for seven years, taking over the whole work of the practice from 1897 until his illness in the autumn of 1902.

In 1898 he noticed that the circulation in one of his eyes was not right, and, being afraid that his microscope work would be interfered with, he consulted Mr. Hartridge, and was ordered complete rest at once. He went to a quiet village in Sussex, and spent most of his holiday lying in a hammock in the garden, and by the autumn he had so far recovered as to take up his work as usual.

Early in the following year he was busy with an epidemic of influenza; his whole family were laid up with it, and probably he had it himself, without realising it, for he was left with a racking cough for many weeks. A long holiday spent in the North of Scotland seemed to suit him and set him up well. Whilst there he took a great deal of exercise, fishing and wading streams all day and going long expeditions to various lakes and mountains, often cycling from thirty to fifty miles in a day, and while there feeling no fatigue. But shortly after returning to his work he felt that his heart was not right, and on seeking medical advice his fears were confirmed. He gave up at once all active exercise and pursuits, and tried to do the work of his practice quietly, feeling that he could not be happy doing nothing, and that he would like, if possible, to die in harness.

In October, 1902, he had a severe anginal attack which convinced him that he was not equal to the exertion of his practice. Under medical advice he took absolute rest for three months, but early in 1903 he left London for good. After staying a short time in the Isle of Wight, he went to Brockenhurst in the New Forest, where he hoped to live awhile. He took much interest in a new house which was being built for him, though he himself often doubted whether he should ever live in it.

For about six weeks before his death he was able to do less and less, so that sitting in the garden reading and watching the house building, and taking a weekly photo of it to send to his son at school, were almost his only interests; but his patience and contentment never waned, and in spite of frequent sense of much discomfort, and of

even occasional anginal attacks, he retained an interest in everything and everyone round him, ever thoughtful of everyone else's comfort.

But on June 28th, after two days' acute illness, borne with the same strong patience and courage which had upheld him during three years of ill-health, the end came. Truly in the words of the poet:

"He had done his work and held his peace and had no fear to die."

Dr. William Henry Corfield, Professor of Hygiene at University College, London, widely recognised, not only in the metropolis but over Britain generally, as a leader in sanitary science, died at Marstrand, Sweden, whither he had gone for the benefit of his health, on August 26th, 1903, at the age of 59.

Professor Corfield was elected a Fellow of the Society only in 1898, and although a voluminous contributor to the literature of Preventive Medicine, he did not enrich the Society's 'Transactions.'

Born at Shrewsbury in 1843, Corfield was educated at Cheltenham Grammar School, and subsequently at Oxford, where he obtained a Demyship at Magdalen College. His career at the University was very distinguished, for in 1863 he took a "first" in Mathematical Moderations, and again a "first" in the Final Schools, with, in addition, a "first" in the Final Natural Science School. In 1864 he gained the Sheppard Medal Fellowship at Pembroke College, in 1866 the Burdett-Coutts Geological Scholarship, and in 1867 the Radcliffe Travelling Fellowship. Meanwhile he had joined the medical faculty of University College, and took his M.B. degree at Oxford in 1868 and his M.D. in 1872. At the Royal College of Physicians he was admitted a Member in 1869 and elected to the Fellowship in 1875.

Whilst holding the Radcliffe Fellowship Dr. Corfield visited and studied at many of the medical centres on the continent, especially working at hygiene, to which department he had already resolved to devote himself. Return-

ing to London he was in 1869 appointed the first Professor of Hygiene at University College, where he inaugurated a special laboratory.

Dr. Corfield was appointed Medical Officer of Health for St. George's, Hanover Square, and in 1899 Consulting Sanitary Adviser to H.M. Office of Works, and at the International Congress of Hygiene and Demography of 1891 held in London, he was one of the joint Hon. Secs. and took a very active part, not only in the proceedings, but also in its arrangements.

Dr. Corfield was President of the Epidemiological Society, Past President of the Society of Medical Officers of Health, and Vice-President of the Sanitary Institute. He was an Honorary Corresponding Member of the Royal Academy of Medicine in Belgium, the Imperial Society of Medicine, Constantinople, and the Italian Royal Society of Hygiene; he was an Honorary Member of the French Society of Hygiene and of the Hungarian Society of Public Health and a Fellow of the Medical Society of Sweden.

He contributed largely to the literature of preventive medicine. Among his publications may be mentioned 'A Résumé of the History of Hygiene' (1870); 'A Digest of Facts Relating to the Treatment and Utilization of Sewage' (3rd edition) (1887); 'Dwelling Houses; their Sanitary Construction and Arrangements' (of which a fourth edition appeared in 1898); 'Health' (1880); 'The Laws of Health' (of which a ninth edition was published in 1896); 'Diseases and Defective House Sanitation' (1896) (which has been translated into French, Italian, and Hungarian); 'The Etiology of Typhoid Fever and its Prevention' (1902); co-author of Reports of British Association Sewage Committee (1870-6); 'A Treatise on Hygiene and Public Health' (1892). Among papers read before societies may be named "Alleged Spontaneous Production of the Poison of Enteric Fever," published in the 'Transactions of the Epidemiological Society' (1874); and "Sore Throat caused by Slight Escapes of Coal Gas,"

published in the 'Transactions of the Society of Medical Officers of Health' (1887).

Dr. Corfield collected a large library. He was a connoisseur of "binding" as well as of rare books; he also possessed a large number of valuable prints and woodcuts. His pastime was angling. A few years ago Dr. Corfield's health began to fail rapidly, and he suffered greatly from dyspepsia.

Dr. Corfield was an able man, and claims the merit of having created a new profession, but he developed the practical rather than the scientific side of hygiene. He was clear headed and made an excellent witness, and probably understood the drainage of a town house as well as anybody.

Mr. William Edward Image died on September 26th, 1903, at Harringswell House, near Mildenhall, Suffolk, at the very advanced age of 96 years. He must, therefore, have been one of quite the most elderly members of the profession. He had retired, however, from practice for fully thirty years before his death.

Elected to the Fellowship of the Society in 1847, Mr. Image contributed a paper on "A Case of Enlargement of the Left Mamma," to which is added an anatomical and pathological description of the tumour, by the author and T. G. Hake (vol. xxx). It was communicated by Robert Liston, F.R.S., and read April 13th, 1847. In it was retailed the case of an enormous arterio-venous nævus, with characteristic skin invasion, pulsation, and large superficial dilated veins of three years' growth in a girl of twenty-one, attributed possibly to a blow. It was treated, after consultation with several eminent London surgeons, as was then one of the recognised methods of dealing with large mixed nævi, by reflecting skin flaps from off the tumour, and ligaturing the base of the tumour *en masse*. The patient died twenty-two hours after the operation, apparently of shock, continuous hæmorrhage, and septicæmia. An account of the dissection after death of the

tumour is given, and the theory advanced for the origin and growth of the tumour is that of a primary obliteration of the costal branches of the internal mammary vein, followed by a hypertrophy of the arteries supplying the gland and dilatation of the veins of the gland owing to inability of the trunk veins to carry off the superabundant blood.

Mr. Image was a student of Guy's Hospital during the time when the Medical School of St. Thomas's and Guy's Hospitals were united, and he was a contemporary of the late Mr. Cock; subsequently he proceeded to Paris, graduating there in 1828 as "Bachelier es Lettres." There Mr. Image married, but returned to England in 1830, on the outbreak of the revolution which deposed Charles X and placed Louis Phillipe on the throne of France. In this year he qualified, passing "The Hall," and in the following year he became M.R.C.S.England, whilst in 1844 he was elected one of the first batch of Honorary Fellows, being at the time Surgeon to the West Suffolk Hospital at Bury St. Edmunds.

Mr. Image's professional knowledge, skill, and acumen were of a very high order, and his services were in requisition over a wide area round Bury St. Edmunds. He took an important part in putting a stop to criminal arsenical poisoning, which in the "forties" was rife in the eastern counties, he being frequently called upon to give evidence in these cases at the assizes. Mr. Image was both a Justice of the Peace and a Deputy Lieutenant for Suffolk, whilst in 1887-8 he served the office of High Sheriff of that county.

Mr. Image was twice married, and leaves one son, Dr. Francis Edward Image, who succeeded his father in practice at Bury St. Edmunds.

I have received the following particulars from Dr. Ferrier, who was his assistant for a year in 1869-70:

"Mr. Image, notwithstanding his great age, enjoyed excellent health and mental vigour until within a year or two of his death. He was a man of dignified presence and

courtly manner. He had a rich fund of anecdotes of his life and of stirring times in Paris; of his early professional struggles; and of the eminent consultants of the past generation, with most of whom he came in contact in the course of his large and important practice. Sir Benjamin Brodie was a special favourite. He was a most accomplished practitioner, and I often marvelled at his extraordinary versatility and ability in every branch of surgery and medicine. He took a keen interest in all that was new in the 'schools.' He spent many hours with me in his well-equipped toxicological laboratory, which he handed over to me for my microscopical work on the brain. I met many notable people at his house, among others the famous George Borrow, who was an old and intimate friend of his. His hobby was stamp-collecting, and in this, as in most things, he excelled. The year I spent with Mr. Image was a delightful experience, and I learnt much from him which has been of great service to me in my professional career."

William Johnson Walsham, Surgeon to St. Bartholomew's Hospital, died at his London residence, 77, Harley Street, on October 5th, after an illness of about ten weeks' duration, in his 57th year. Mr. Walsham's death, occurring in the zenith of his fame as a hospital surgeon and as a teacher of exceptional ability, is a loss which will be felt acutely, not only in his own school and by a wide circle of professional acquaintances, but even throughout all English-speaking countries by the fame of his well-known handbook, 'The Theory and Practice of Surgery.'

Mr. Walsham was elected a Fellow of this Society in 1873. He filled the offices of Member of the Library Committee, of Member of Council, and of Referee, and was the author of eight communications to our 'Transactions.'

(With T. Gilbeart Smith) "Case of Extreme Pharyngeal Stenosis, the Result of Syphilis."—Vol. lxiii.

This case, in which the pharyngeal stenosis was found to be immediately above the rima glottidis, and in which

both dyspnœa and dysphagia were urgent, was treated in successive stages by tracheotomy, dilatation, and division of the strictured pharynx, with gratifying improvement, the tracheotomy wound being allowed to heal before the patient left the hospital. The literature of the subject is very fully gone into.

(With Alfred Willett) "Dissection of the Parts removed after death from the Body of a Woman, the subject of Congenital Malformation of the Spinal Column, Bony Thorax, and Left Scapular Arch, with Remarks on the Defects in Development producing the Deformities."—Vol. lxiii.

(With Alfred Willett) "Second Case of Malformation of the Left Shoulder Girdle; Removal of Abnormal Portion of Bone; Probable Nature of Deformity."—Vol. lxvi.

These remarkable cases are exhaustively treated in the two papers. The embryology and comparative anatomy of both were worked out by Mr. Walsham alone. I am glad to make this statement.

"Case of Intra-peritoneal Rupture of the Bladder; Abdominal Section; Suture of the Bladder; Recovery."—Vol. lxxi.

"A Case of Intra-peritoneal Rupture of the Bladder; Suture; Recovery; with Remarks on the Inflation Test. With a Table of Twenty Cases of Rupture of the Bladder treated by Suture since 1888."—Vol. lxxviii.

The cases recorded were some of the earlier operations performed for traumatic rupture of the bladder. The subject is made the more valuable by the tables of recorded cases.

"Case of Wound of the Femoral Artery and Vein. Traumatic Varicose Aneurism; Ligature of both Artery and Vein; Recovery. With Remarks on the Treatment of Wounds of the Femoral Artery and Vein."—Vol. lxxi.

"A Case of Extirpation of a Large Non-pulsating Aneurism involving the Common, Internal, and External Carotid Arteries of the Right Side of the Neck. With Remarks on Non-pulsation in Aneurisms, and the Treatment of Aneurisms by Extirpation."—Vol. lxxx.

These two communications deal with formidable affections of large blood-vessels, and are evidence of the courage and resource of the operator.

"Two Cases of Knee Trouble, with Difficulty in Locomotion depending on an Elongation of the Ligamentum Patellæ, treated by Transplantation of the Tubercle of the Tibia; with Remarks."—Vol. lxxvi.

An interesting orthopædic case which brings out the ingenuity and mechanical bias of the surgeon.

William Johnson Walsham was born in London on June 27th, 1847, the elder son of Mr. William Walker Walsham, of Wisbech, Cambridgeshire. He was educated privately at Highbury under the Rev. Dr. Johnson, and early in life showed so great a mechanical bent that he was apprenticed to an engineering firm. But the early hours and the physical labour required in the "shops" soon proved too much for his strength, and he was compelled reluctantly to turn his attention to less exacting work.

Walsham entered as a student of St. Bartholomew's Hospital in May, 1867, and, like many another who has subsequently been elected to its staff, without an introduction, and without a friend in the place. He was at this time a year or two older than the majority of his fellow students, and he at once demonstrated his intellectual superiority and his manual dexterity by obtaining the chief prizes in the dissecting room, the Treasurer's or junior practical anatomy prize being awarded him at the end of his first winter session in 1868, and the Foster or senior practical anatomy prize falling to his lot at the end of his second winter session in 1869. In 1869 he obtained the senior scholarship in anatomy, physiology, and botany, having previously gained the junior scholarship. In each of these four events Mr. Alban Doran was placed second. Walsham also obtained a prize dressership under Sir James Paget, and in 1869 was awarded the gold medal given by the Society of Apothecaries for proficiency in materia medica and pharmaceutical chemistry. In this year he obtained the L.S.A. diploma.

Walsham now went to Aberdeen with the object of obtaining a degree in medicine. One who was in residence at Aberdeen during the same year, and with whom Walsham preserved a lifelong friendship, has most kindly supplied me with some very interesting details of Walsham at this period of his life. He says:

"Walsham was a delicate man, a martyr to dyspepsia, without any of the love of athletics and sport which I revelled in. I kept a bull terrier and used a walking stick, a combination which he frequently assured me, upon the authority of Mr. Holden of Bart.'s, led a man always to the devil! His love for his work in every branch was intense, and at the end of his career in Aberdeen he was a walking encyclopædia in all the subjects. Struthers, the professor of anatomy, spoke frequently of his perfect knowledge of that subject, and admired his dissection very much. Whether it was botany or zoology, anatomy or medicine, etc., etc., he was equally good at it. Always willing and glad to give a helping hand to others, he never spared himself so far as work was concerned. He was an enthusiastic dancer and lover of music. As a performer on the cornet he never attained to excellence. This was his only failure—and I am answerable for that. His one melody was the 'Last Rose of Summer,' and as he invariably selected midnight for his hour of practice it became necessary for me to restrain him by vigorous measures.

"The indomitable perseverance of Walsham is made clear by the following incidents. As a student he was a lamentable failure when speaking at the debating society in Aberdeen. This troubled him very much. I recollect well our returning together after his first effort, when he was smarting under the gibes of some of those who were present. He said to me when we arrived at our rooms, 'I *will* speak; even Demosthenes managed it with the help of the pebbles on the beach. Why shouldn't I?'"

All who in later life have heard Walsham either lecture, give clinical instruction, or join in debate will recognise how absolutely he overcame this difficulty.

"The second thing was his inability to express clearly his thoughts in writing. His thesis was a sore trial. We can say now, if we judge him by his Handbook on Surgery, that he certainly attained excellence in his form of expression and order."

He returned to London to take the M.R.C.S.Eng. on November 17th, 1871. He was nominated by Dr. Francis Harris to act as House Physician at St. Bartholomew's Hospital from May 1st, 1871, and this post he filled for nine months when he exchanged with Mr. Charles Irving and became House Surgeon to Mr. Holmes Coote for the remainder of his year of office.

By this time Walsham's ability and love of work had won recognition by his teachers, and in 1872 he was appointed Assistant Demonstrator of Anatomy. In the next year he became full Demonstrator, a position which he held until 1880, and the museum still contains some of his exquisite dissections. In 1880 he became Demonstrator of Practical Surgery, in 1889 he was appointed Lecturer on Anatomy, and in 1897 he exchanged this lectureship for the post of Lecturer on Surgery.

On the retirement of Mr. Holden, a contest for the vacant office of Assistant Surgeon resulted in Walsham's election by a majority of only three votes over Mr. Harrison Cripps, and thus on March 10th, 1881, he became a member of the surgical staff of the hospital and was immediately afterwards appointed Demonstrator of Orthopædic Surgery, a position he held until his appointment as full Surgeon to the Hospital in 1897. He was elected Surgeon to the Metropolitan Hospital and to the Royal Hospital for Diseases of the Chest in 1876, and he held the latter position for about eight years. At the Metropolitan Hospital he took charge of the department for diseases of the throat, and he was elected to the position of Consulting Surgeon in 1896. Later, in the capacity also of Consulting Surgeon, he became attached to the Sevenoaks Hospital for Diseases of the Hip and to the Bromley Cottage Hospital.

At the Royal College of Surgeons of England Mr. Walsham was elected a Fellow after examination on June 10th, 1875. He served the office of Examiner in Anatomy on the Conjoint Board from 1892 to 1897 and was a member of the Court of Examiners from 1897 to 1902, but found the duties of the latter office so trying that he did not seek re-election at the expiration of his first term of office.

On two occasions, in 1896 and in 1900, Walsham unsuccessfully contested at the annual meeting election to a seat on the Council of the College. It may be doubted whether, if he had been elected, he would have left his mark, for, to be just, it must be confessed that Walsham did not come to the front, or even take much interest in committee work, or in matters outside his absorbing interest in surgery. Not infrequently he held peculiar views on school matters, and, in general on most mundane affairs, he was distinctly pessimistic in his views.

Walsham was a sound rather than a great surgeon. His full mastery of the subject and his knowledge of anatomy made him an enterprising and, when occasion required, a bold operator, but at operations he had a curious habit of seeking counsel with those assisting him, possibly with the object of testing their ability and knowledge.

As an author Walsham will be best remembered for his 'Theory and Practice of Surgery,' and for his 'Deformities of the Foot,' published in 1895, in collaboration with Mr. Kent Hughes of Melbourne. From his long tenure of the appointment of Surgeon in charge of the Orthopædic Department at St. Bartholomew's, Walsham's practice took very naturally this direction.

The late Mr. Walsham was an enthusiastic Freemason; he was one of the founders and a past Master of the Rahere Lodge, and had held high office in the craft, for he was a Past Grand Deacon in the United Grand Lodge of England.

He had been in his day an ardent volunteer, looking forward to the annual Easter reviews, which, if possible, he never failed to attend, and more than once he has said to

me how much he regretted he had not gone into the army.

For some years Walsham spent his holidays at Forest Row, Sussex, where he had acquired a picturesque cottage bordering on Ashdown Forest. This he transformed by judicious additions and alterations into a delightful residence. He revelled in his garden. This he had laid out and judiciously planted. It was always a pleasure to him to watch the growth of trees and shrubs which he had nurtured. Both at Forest Row and in Harley Street he was greatly given to hospitality, and he was a charming host.

A few years before his death he became a member of the Savage Club, and he entered into its entertainments with keen delight and appreciation.

Walsham had for some eighteen months been aware of the presence of a small amount of albumen in his urine, but from his student days he habitually overworked, and without doubt overtaxed his powers, and thus gradually but surely undermined a constitution never robust. For some years, as each summer session drew to a close, he complained of lassitude and a longing for rest, yet, when October 1st came round, he returned to work as fresh and indefatigable as ever. On one of the late days in July I saw my friend for the last time quite accidentally in the street. In answer to a question of surprise at finding him in London, he said "I am very ill, very seriously ill, I fear. I have trouble with my eyes, and have just seen Holmes Spicer, who says I must go off at once to some quiet German water resort and have a complete holiday in a pure air." Knowing his wont to take a gloomy view, I tried to cheer him, remarking what great benefit he had always derived from his autumn holidays, but he merely replied "I am very ill."

It is noteworthy that after giving up his wards to Mr. Power in July, on returning to his house he said, "I have paid my last visit to the hospital. I shall never go there again."

Shortly after this he left London for Grindelwald, and remained there three weeks, but did not derive as much benefit from the mountain air as he had anticipated, and on August 27th he went to Wiesbaden. There, on the following day, serious symptoms of breathlessness developed. He was attended most assiduously by his brother, Dr. Hugh Walsham, and by Dr. Pfeiffer, whilst on two occasions Sir Lauder Brunton travelled from Switzerland to see him. The symptoms showed no signs of abatement, and at his own earnest desire he was brought to England on September 25th. His friends, Sir Lauder Brunton, Dr. Goodhart, and Dr. de Havilland Hall, were unceasing in their attentions, but in spite of all that could be done he sank gradually and died peacefully in his sleep in the early morning of October 5th.

He married in 1876 Edith, the elder daughter of Joseph Huntley Spencer, Esq., of Hastings, but had no family. Mrs. Walsham, with his mother and younger brother, Hugh Walsham, survive him.

Mr. Walsham was buried at Highgate Cemetery on October 9th, the funeral being attended by a large number of his colleagues and friends. There was also a memorial service in the church of St. Bartholomew the Less, which was literally full to overflowing.

To do his "duty" thoroughly to the very utmost of his power was the keynote of Walsham's life, and to him duty, both in its conception and in its performance, meant a high standard of excellence. No amount of time, no question of expense, no amount of personal attention, and no thought of the physical labour involved ever daunted or made him hesitate in boldly facing the full responsibilities of any appointment or of any work which he had undertaken. This devotion to duty characterised his whole career. It was this trait that brought him to the notice of his teachers when a young man, and it was this which made him a great teacher and eventually brought him professional success as a surgeon. And yet in ordinary life he was singularly modest, diffident, and

inclined to self-effacement. In much of his work in earlier life, notably in the preparation of diagrams, etc., for his lectures, he had a most devoted and able assistant in Mrs. Walsham.

Dr. George Thin died at Nice on December 27th, 1903, aged 65.

Dr. Thin practised at Shanghai for some years, but for upwards of twenty-five years and until about a year ago, he had been a consulting physician in London, latterly residing in Harley Street. Dr. Thin was an authority in tropical diseases, as well as in skin affections.

Dr. Thin joined this Society in 1874, and in 1893 was elected to the Council. He was a very frequent contributor to the Society's 'Transactions'; his communications amounted to the large number of fourteen, the subjects of which are as follows:

"On the Pathology of Lupus Erythematosus."—Vol. lviii.

"On some of the Histological Changes found in Cancer of the Skin or Epithelioma, with special reference to the source of the newly-formed Epithelial Cells."—Vol. lix.

"On the Proportion of Red Corpuscles in the Blood in some Skin Diseases."—Vol. lxi.

"On the Condition of the Skin in Tinea Tonsurans." —Vol. lxi.

"The Nature of Iodide of Potassium Eruption."—Vol. lxii.

"On the Pathology of Lupus, with special reference to the appearance described as Giant-cells."—Vol. lxii.

"On the Development of a Layer of Elastic Fibres in Duct Cancer of the Breast."—Vol. lxiv.

"An unusual Case of Warty Growths on the Face."— Vol. lxiv.

"On the Bacillus of Leprosy."—Vol. lxvi.

(With F. J. Wethered) "Symptoms and Pathology of a Case of Acute Inflammation of the Mucous Membrane of the Ileum from Climatic Causes."—Vol. lxxiv.

"On the Symptoms and Pathology of Psilosis" (linguæ et intestini).—Vol. lxxv.

(With R. J. Marshall) "The Parasite of Malaria as observed in the Malarial Fevers of the South of Spain." —Vol. lxxix.

"A Note on the Appearances found in the Tissues in a Fatal Case of Pernicious Malaria at Sierra Leone." —Vol. lxxix.

"A Further Contribution towards the Pathology of the Pernicious Malarial Fevers of Sierra Leone, and our knowledge of the Parasite with which they are associated."—Vol. lxxxi.

It is not practicable to give a *résumé* even of these papers, but having perused them in justice to Dr. Thin's memory, I would state that one and all are characterised by remarkable completeness, and evidence a thorough mastery of the subject dealt with. Alone they would establish a reputation for the author of being a physician highly educated, of studious habits and widely cultured, and bringing a philosophic spirit to his work.

The late Dr. Thin has bequeathed £100 to the Society, and thus has added another claim to our grateful remembrance of his connection with it.

George Thin was born at Elie in 1838. His father was captain of a vessel which traded between certain ports on the east coast. A half-brother, Mr. Alexander Michie, was an authority on matters relating to the Far East, especially China, where he resided for many years, and was a frequent contributor to 'Blackwood's Magazine' and other high class periodicals. It was he who wrote the stirring articles in the 'Times' during the war between Japan and China which attracted so much attention. He also wrote an interesting book, 'The Overland Route from St. Petersburg to Pekin.'

Dr. Thin was educated at Elie by Dr. Maclaurin, father of Sir Henry Maclaurin, Chancellor of the University of Sydney. He there gained a bursary, with which he came to Edinburgh with the intention of studying for the Free

Church ministry. He shortly afterwards gave up this idea and went in for medicine. He studied at Surgeons' Hall, Edinburgh, and in 1858, when only twenty years of age, obtained the diploma. Two years later he took the degree of M.D. at St. Andrews. He was a conscientious, hard-working student, but did not obtain any prizes, preferring to be a good all-round man rather than to excel in any one subject. He was a keen anatomist and acted for two years as demonstrator of anatomy. Shortly after qualifying, he established himself in practice at Penicuik, where, notwithstanding his youth, his success was immediate.

In 1865 he went to Shanghai, where he remained in practice till 1870, and there it was that he laid the foundation of his wide knowledge of tropical diseases, subjects which occupied much of his after life. He then studied for a short time at Vienna, and after again visiting Shanghai in the following year for a brief period, he settled down in Queen Anne Street. He made a special study of dermatology, visiting both Paris and Vienna for the purpose. Subsequently he moved to Harley Street, where he remained till the failure of his health at Christmas, 1902, necessitated his retirement from active work. His health had for some time previous been somewhat indifferent, a severe attack of thrombosis having confined him to bed for several weeks. In the spring he was moved to Nice, and on his return to London made some effort to resume touch with his work, but after a relapse he decided to retire definitely. He spent the autumn at Brighton, but having experienced so much benefit the previous year from his stay at Nice, he decided to return there for the winter. He bore the journey well, but a fortnight later his strength gave way, and he died on December 27th, 1903. Mrs. Thin survives him.

The late Dr. Thin was President of the Section of Tropical Medicine at the British Medical Association Meeting at Bournemouth in 1900, and Vice-President of the Section of Dermatology at the British Medical Association some years back.

He published the following works:—

1. "On the Lymphatic System of the Cornea."—From the 'Lancet,' 1874.

2. 'On the Minute Structure of Muscle and Tendon, and some Notes regarding the Structure of the Cornea.' —Edinburgh, 1874.

3. "Contribution to the Anatomy of Connective Tissue, Nerve, and Muscle, with special reference to their connection with the Lymphatic System."—Royal Society 'Proceedings,' 1874.

4. "On Traumatic Inflammation of Connective Tissue." —Royal Society 'Proceedings,' 1875.

5. "On Inflammation."—'Edin. Med. Journ.' 1876.

6. 'Introduction to Practical Histology.'—Lond., 1877.

7. 'Malignant Papillary Dermatitis of the Nipple and the Tumours with which it is found associated.'—London, 1881.

8. 'On Cancerous Affections of the Skin,—a Treatise on Epithelioma and Rodent Ulcer.'—London, 1886.

9. 'Recent Papers on the Bacilli of Leprosy.'—Translated.

10. 'Pathology and Treatment of Ringworm.'—London, 1887.

11. 'Psilosis or 'Sprue,' its Nature and Treatment.'— London, 1888. 2nd edition, 1897.

12. 'Leprosy.'—London, 1891.

Mentally Dr. Thin was very vigorous and far seeing; by nature given to scientific methods of thought; never accepting anything on trust that was capable of proof. To the end of his days he was a student. A widely-read man in modern literature, he was fairly well versed in standard literature of the last two centuries. Naturally reserved and cold, but yet very steadfast and kind-hearted where he had once given his confidence. As an examiner of candidates for fitness in physique, he was perhaps unequalled. A friend says in concluding his observations, "A fine edifice of straight hewn sound stone, with nothing jerry-built—that was Thin."

John Knowsley Thornton, for many years Surgeon to the Samaritan Hospital, and who before failing health compelled him to relinquish both hospital and private work in London, was a recognised leader in abdominal surgery in London, died in his 57th year at his residence, Hildersham Hall, on January 3rd, 1904.

Mr. Knowsley Thornton was elected a Fellow of the Society in 1876. He did good service on the Library Committee, serving from 1886 to 1890 and again from 1893 to 1895. He was elected on the Council in 1891. He made five contributions to the Society's 'Transactions' viz.:

"Twenty-five Cases of Ovariotomy, with Remarks on the Course and Treatment of the Fever so frequently following the Operation."—Vol. lx. The author in this paper deals with that mild type of fever after operation, which he regarded as being dependent neither upon sepsis, nor upon peritonitis, and in which he had found the "ice-cap" of the greatest benefit. In this series of twenty-five cases the mortality was 7, or 28 per cent.

"One Hundred and Seventy-two Antiseptic Abdominal Sections, with Remarks on the Causes of Death in the Fatal Cases."—Vol. lxiv. In this paper the author demonstrates the value of the strict adoption of the Listerian antiseptic measures in ovariotomy by which mortality, in his experience, had been reduced from 24 per cent. to 4 per cent. I may mention that Knowsley Thornton continued to employ the strictest Listerian routine, including the spray, at his operations until his retirement from the Samaritan Hospital.

"Three Hundred Additional Cases of Complete Ovariotomy and Twenty Cases of Exploratory Operation."—Vol. lxx. In this series there were twenty-one deaths, or a mortality of 7 per cent., although in a hundred consecutive operations there had not been a single death, and he pleads therefore that percentages of mortality are likely to be misleading unless account be taken of all the facts.

"Two Cases of Splenectomy," Vol. lxix, one of which

was an instance of cystic disease of the spleen, the operation was uncomplicated and an uninterrupted recovery followed, whilst in the second, a general parenchymatous hæmorrhage immediately followed upon the removal of the viscus, death rapidly ensuing. Post-mortem, a large retro-peritoneal coagulum was found, the result of failure of the ligatures to secure the pedicle.

"Twenty-five Cases of Nephrectomy by Abdominal Section."—Vol. lxxii. All the cases are reported in detail, and the author lays stress on the advantage of this method over the lumbar operation. Five deaths give a mortality of 20 per cent.

John Knowsley Thornton was born on January 15th, 1845, and was the son of the Rev. John Thornton, Vicar of All Saints, Northampton. He was educated at Rossall School, and at the age of 22 he entered the University of Edinburgh, graduating M.B., C.M., in 1871. In the same year, at the age of 26, he was appointed Lord Lister's House Surgeon at the Royal Infirmary. After a short period spent in general practice at Ford in Northumberland, an opportunity offered of coming to London. Knowsley Thornton was introduced to Sir Spencer Wells, whose assistant he became, and he also gained a position on the Surgical Staff of the Samaritan Hospital, then located in Lower Seymour Street, and as Sir Spencer advanced in years, so Knowsley Thornton, who had steadily built up a high reputation as a sound surgeon, a skilful and prudent operator, and more than all as a thorough believer and adept in antiseptic surgery, grew famous both at the Samaritan and in private practice in abdominal surgery. This position he held for fully ten years, and it was only terminated by his health giving way; indeed, although of good physique he had never enjoyed robust health since the age of 18, when he had an attack of gout. This affection frequently recurred and greatly interfered with his work, so that in 1891 he gave up his hospital work, and in 1898 retired altogether from practice and went to live at Hildersham Hall, where he

enjoyed a country life and for a time seemed in better health; after a time, however, he was attacked with peripheral neuritis, under which his strength gradually gave way. Mr. Knowsley Thornton married twice. His first wife was a daughter of Captain Paterson, and by her he had one son and two daughters; his second wife, who, with one daughter, survives him, is a sister of the fourteenth Baron Windsor.

Sir William Raymond Kynsey, C.M.G., J.P., died at Horsham on January 11th, 1904, at the age of 63 years, his chief sphere of professional duty having been in Ceylon, where for some twenty-four years he had filled the post of Principal Civil Medical Officer.

Sir William Raymond Kynsey was elected a Fellow of the Society in 1888. He did not make any contribution to the 'Transactions.'

William Raymond Kynsey was born at Athy, Co. Kildare, being a son of the late Dr. Thomas Brett Kynsey, J.P., and was educated at Trinity College, Dublin. He obtained the L.R.C.S.Ireland in 1861 and the L.R.C.P. Ireland in 1862, its Membership in 1880, and was elected to the Fellowship in 1886.

Joining the Army Medical Service, he was appointed an Assistant Surgeon in 1863, and was attached to the Royal Artillery, serving in India and Ceylon. He went through the Ashantee War in 1873-4 and was present at the capture of Coomassie, receiving the medal for this campaign.

In 1875, after being placed on half-pay, Kynsey was selected for the appointment of Principal Civil Medical Officer in Ceylon. For twenty-four years his career was one of great activity. He held numerous offices, amongst others those of member of the Legislative Council, Municipal Councillor of Colombo, a magistrate and visitor of the gaols of Ceylon. He was elected President of the Ceylon Board of the British Medical Association, and in 1888 represented his branch on the Council.

He received the C.M.G. in 1888, and the honour of knighthood in 1897, retiring finally in 1899 after twenty-eight years of service.

Sir William Raymond Kynsey wrote on Parangi and on Ankylostomiasis, and was an authority on the diseases of tropical climates, of Ceylon especially.

He married in 1866 Isobel Keith, a daughter of the late Captain Jolly, of the old East India Company Service who survives him.

LARGE BILE CYST OF THE LIVER: JAUNDICE WITHOUT CHOLELITHIASIS

INCISION AND DRAINAGE: RECOVERY

BY

ALBAN DORAN, F.R.C.S.

SURGEON TO THE SAMARITAN FREE HOSPITAL

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Dr. Hale White considers that cysts of the liver other than hydatid are very uncommon, seldom give rise to any symptoms during life, and are obscure in their mode of origin. Langenbuch, Waring, and Rolleston seem to be of the same opinion. On that account I think that the present case, where operative interference was necessary, is worth recording.

Mrs. R. C—, aged 42, was admitted into the Samaritan Free Hospital under my care on March 4th, 1903, suffering from deep jaundice and great enlargement of the liver.

She had never been strong, but had not suffered from any malady more severe than two attacks of influenza, the last being in December, 1902, when the jaundice was already marked. None of her near relatives or children

had been subject to jaundice or to attacks of gall-stone colic as far as she could make out after careful inquiry.

She had been pregnant seven times, bearing five children to term. Six years before admission she aborted at the second month, through a shock caused by seeing a man carried to hospital after a street accident. No jaundice was observed as the result of the shock. The second abortion also took place at the second month. It occurred three years before admission, and its cause must be dwelt upon. The patient slipped in her back yard and fell forwards, striking the right hypochondrium against the edge of a washing tub. A few hours later she aborted. She did not feel much pain in the hypochondrium after the smarting caused by the blow had subsided, and certainly was not jaundiced.

The last normal pregnancy ended by spontaneous delivery in April, 1901, and from that date the patient's health began to deteriorate. After convalescence from the puerperium she consulted Mr. Corrie Keep at the Out-patient Department of the Samaritan Hospital. He detected a movable right kidney. About four months before admission she noticed that her face began to grow yellow. For weeks there was no pain, but vomiting occurred on certain occasions, associated in every case, it would seem, with errors of diet. More than once she had attacks of profuse perspiration. She applied to St. Mary's Hospital, and was for a time under Dr. Luff as an out-patient; enlargement of the liver was detected, but the evidence of hydatid disease was considered doubtful. An attack of influenza greatly reduced her strength. She again consulted Mr. Keep, who noted that the liver was much enlarged. Ten days before admission the patient suffered for the first time from a very violent attack of pain in the upper part of the abdomen, lasting for a few minutes. Several other such attacks followed, and she felt gnawing pains across the epigastrium. She was troubled with diarrhœa, passing abundant semi-solid white stools.

When I first examined the patient she appeared to be a somewhat emaciated woman, deeply jaundiced, the conjunctivæ being of a bright yellow colour. Itching was severe and kept her awake. She was naturally cheerful, and quite free at the time from any depression, a point of interest in relation to an episode during convalescence.

The abdomen was considerably distended, the parietes thin with distinctly enlarged veins. Numerous petechiæ were scattered over the deep yellow skin. In any position there was resonance in the flanks and hypogastrium. To the right of the umbilicus was a large fluctuating swelling, which I noted at the time as in the situation of the gall-bladder; it reached to a little below the umbilical level and was very prominent, bulging under the skin. Hepatic dulness reached to the fourth rib in the line of the nipple. The edge of the left lobe of the liver reached the umbilical level; it was thin, easily grasped, but very tender. The edge of the right lobe in the axillary line was thin; its surface below the hypochondrium felt somewhat irregular. The right kidney was slightly movable and hardly enlarged.

The pelvic viscera seemed healthy, the catamenia had become scanty during the present illness, but remained regular. The pulse was 84, small, hard, and regular; there was no œdema of the legs or of any other part, nor were there hæmorrhoids. The heart and lungs were healthy. The temperature was 100° in the mouth on the night of admission, but fell to normal after rest in bed.

The appetite was fair. The patient could eat fats and sweets with relish, and can do so now after the operation. There was a sensation of weight in the epigastrium after food with frequent nausea, but never vomiting after admission. The tongue was quite clean and not raw. The motions were solid and white; once or twice in the six days before operation they showed a trace of colour. About the same time the fluctuating swelling became less tense and the jaundice slightly less intense.

The urine, examined daily during the six days, was at

first scanty, but the diarrhœa from which she suffered prevented satisfactory determination of the amount excreted every twenty-four hours. On the 8th and 9th it exceeded thirty ounces. During the period in question she took twenty grains of chloride of calcium and three minims of liquor strychninæ three times daily (not together). The urine was always turbid and deep orange-brown in colour, the sp. gr. 1022 to 1024; it cleared on boiling, becoming light olive-green; on adding nitric acid, or boiling after the addition of the acid, a precipitate, deep purple in colour, appeared. When the cold test was tried a deep purple and above it an opaque white line developed between the urine above and the acid beneath. There was no sugar.

The great enlargement of the liver suggested malignancy, but the patient's health, though feeble, was not so bad as in most cases of large growth of the liver. The diarrhœa appeared to account for the emaciation.[1] The cystic swelling was very like a dilated gall-bladder as far as its position was concerned, but it was quite fixed. Hydatid disease seemed possible. I determined to make an exploratory incision and empty the fluid, doing more if practicable and advisable.

Accordingly I operated on March 10th, with the assistance of Mr. Butler-Smythe; Major Carr-White, I.M.S., worked the aspirator, and Dr. Collingwood administered ether and chloroform.

The patient was placed with a large pad under the loins, as when choledochotomy is performed. I made an incision along the outer border of the right rectus over the prominent fluctuating swelling. There was no oozing; one vessel required ligature. A large cyst appeared with semi-opaque greenish-brown walls. I took it at first for gall-bladder. A pad was slipped into the kidney pouch and another below the liver; then the aspirator was used,

[1] It was possibly due to some medicine which she took after the attack of influenza.

and two pints eight ounces of pure deep green bile were removed.

When it collapsed the relations of the cyst puzzled me at first; but on raising its lower part I found the gall-bladder perfectly healthy behind and below it. The cystic, hepatic, and common ducts were plainly visible, quite normal, and empty. The pancreas was soft and supple, and there were no omental or intestinal adhesions. The right lobe of the liver was enlarged, the surface was not irregular, but opaque from perihepatitis; the left was of a uniform rich orange-brown colour, with the capsule quite free from opacity. No calculi nor any more cysts could be felt in the liver. The great cystic cavity occupied the lobulus quadratus and apparently the whole of the left half of the right lobe to the diaphragm and the back of the abdominal cavity. The gall-bladder was about three inches long, thin and flaccid; it contained a little fluid, presumably clear, and was very movable; the cyst had pushed it away from its groove. Its walls were healthy, and no calculi could be felt. The right kidney was healthy and mobile.

I inserted a quarter-inch red rubber tube into the cyst and sewed the edges of the opening, which I made around the aspiration puncture, to the peritoneum at the upper angle of the wound. The rest of the peritoneum was united with a continuous No. 1 silk suture, the sheath of the rectus (I had not divided the lateral muscles) in the same manner; the wound in the integuments was closed with interrupted silkworm gut.

The patient slept well a few hours after being put to bed; I withdrew on the same evening sixteen ounces of pure green bile. Dr. Cuthbert Lockyer examined the bile removed at the operation; it contained no trace of clot or hydatid elements.

The temperature during convalescence never exceeded 100°; the pulse was 96 for several days. The itching disappeared within twenty-four hours. The area of hepatic dulness was found to be reduced to its normal

limits; the left lobe became less and less tender to touch. During the first week the dressings were saturated with green bile, and about a pint of bile was removed through the tube daily by aid of a syringe. The rubber tube was gradually shortened, but was not entirely removed until the seventeenth day.

By the second week the jaundice began to diminish steadily; the conjunctivæ were quite white after April 1st. The urine soon cleared, but a trace of albumen persisted for three weeks. At first I gave liquor strychninæ in moderate doses. I also administered five grains of fel bovinum three times daily from the third to the sixteenth day. The escape of bile set up a troublesome pustular eruption on the fourteenth day.

Early in the third week the discharge of bile began to lessen. The motions were still white. The patient was depressed, as is often the case in jaundice, but the complexion continued to clear. The patient was allowed port wine and took quinine. On April 3rd the nurse informed me that the motions passed in the morning were coloured. Next day I examined them; they were of a medium brown colour. The patient was once more cheerful; the conjunctivæ had become pearly white. Henceforward till April 17th, when the patient left the hospital, thirty-eight days after the operation, the motions remained dark, and the discharge from the fistulous track left after removal of the tube diminished. An ounce or two of purulent bile was removed every morning through the track; the cyst was occasionally washed out with chinosol.

At her discharge from hospital, on April 17th, the patient was in excellent health. The fistula had a narrow orifice, and the probe passed four inches upwards and backwards along a narrow track, and on careful probing I detected a cavity or pouch, two inches from the surface, into which the probe passed for about two inches. The cavity, owing to the nature of the liver tissue, could not have closed up entirely, but probing could not determine precisely how far it had closed. The

patient came up to the hospital occasionally after her dismissal to have the wound dressed; the cavity was syringed out daily at home with Condy's fluid.

On May 1st I found some pieces of a soft dark brown material mixed with pus in the dressings over the orifice of the fistula; some clot seems to have come away on the previous day. Dr. C. Lockyer kindly examined the brown material; it gave negative results with Gmelin's and Pettenkoffer's tests, and an ethereal extract showed no cholesterin.

On October 19th, over seven months after the operation, I had an opportunity of examining the patient. Her complexion was quite clear and she had gained flesh; the catamenia continued regular. The fistula was two and a half inches deep; a little pus discharged from granulations around its orifice.

Pathology.—Rolleston, Waring, Hale White, and others who have written on simple non-hydatid cysts of the liver admit that they are exceptional, obscure in their mode of origin, and rarely give rise to any symptoms during life. They further imply that such cysts are usually small. Kilvington states that very large cysts of this class are nearly always single. None of these writers find that simple cysts contain bile. I need not dwell on the cystic degeneration which often involves the kidneys as well as the liver,[1] nor on cystic adenoma where the cysts contain a colourless liquid (Ziegler). Keen, of Boston, U.S.A., has operated in cases of adenoma.

Turning back to simple cysts, I find that specimens in the museums of hospitals in London do not throw much light on the present case. On inquiry I have been informed by the curators and pathologists of these insti-

[1] For fine examples of this condition see F. S. Eve's specimen (Mus. R.C.S., Path. Ser., No. 2758c), and Henry Morris's (ibid., 2758d). Both were from adults. In Eve's case it is stated in the catalogue that the cysts were formed by dilated gall-ducts, and contained straw- and chocolate-coloured fluid. It seems very improbable that the cyst in the present case comes under this category; the right kidney was movable, but not enlarged.

tutions that no example of a large cyst which contained bile is to be found in these museums. Cystic dilatations of intra-hepatic bile-ducts distinctly caused by obstruction of the three outer ducts are not rare, but in my case the outer ducts were not obstructed but empty. There was no evidence in my case of hypertrophic biliary cirrhosis, which causes dilatation of intra-hepatic ducts.

The specimens in the museum of the Royal College of Surgeons are somewhat familiar to me. I will put aside pedunculated cysts of the liver—their origin may or may not be different from that of the cysts entirely inside that organ, but this question cannot conveniently be debated; the different views of Langenbuch and Goodhart as to Ward Cousins' case (Mus. R.C.S., Path. Ser., No. 2758) will be referred to presently. The surgical treatment of pedunculated and of sessile cysts must differ greatly. All the intra-hepatic simple cysts in this museum seem to have contained clear fluid. The only specimen in any way akin to my case is No. 2757B, which I find is figured in Waring's treatise (fig. 22). That author observes that it is of about the size of a walnut, and attached to the anterior surface of the liver immediately above and to the right of the gall-bladder. It seemed to me to be connected with the gall-bladder, and only separated from its cavity by a thin septum; it may therefore represent a congenital malformation of the gall-bladder itself; it held an albuminous fluid. The cyst in my case contained pure bile, and was quite unconnected with the gall-bladder.

When we turn to the question of bile in the liver cyst we find that we cannot assume that the contents prove the origin of that cyst from an intra-hepatic bile-duct. I shall speak presently of a case under Peyton Beale, where retention seemed clearly the cause of cystic dilatations in the liver containing bile; but the authorities to which I have referred do not succeed in distinguishing "serous cysts" from "bile cysts." Rolleston believes that in the earliest stages bile is probably present in simple liver cysts, but disappears as time advances; whilst Ziegler

finds that these cysts are, as Virchow pointed out, sometimes developed from vasa bilifera aberrantia, and in cases where that origin has been demonstrated the cysts did not contain bile.[1]

Thus a bile cyst does not necessarily mean a cyst developed from a bile-duct; possibly it may not always originate in any kind of duct; in my case it might have arisen from the breaking-down of liver tissue with rupture of a duct. I shall presently say more about the accident which happened to the patient, and shall refer to the question of congenital malformation. The cyst was too large to allow of theorising about its origin; I shall therefore dismiss these purely pathological questions, and turn to instances of large liver cysts already published, whilst the possibility of hydatid disease will be discussed when I analyse certain features in my own case.

Reported cases of large non-hydatid cysts.—In several instances cysts of the liver have been found projecting from the surface of that organ, so that they could be removed more or less completely by operation. A few words may be said about these pedunculated cysts. Langenbuch refers to cases reported by Müller of Aix-la-Chapelle, Berg, and Hueter; the latter operated upon a girl aged eleven. The cyst held over four pints of a greyish fluid containing cholesterin; it was removed entire; its adherent part caused bleeding when separated, and a big gap was left in the liver, closed by sutures. The patient recovered. Kaltenbach excised part of the liver during a similar operation, but the tumour was probably a cystic adenoma. The same may be said of Müller's case. The best known removable hepatic cyst was that operated on by Ward Cousins. It simulated an ovarian tumour, and contained two and a half gallons of a clear, limpid, yellow fluid, which apparently was not

[1] I have not dwelt on cysts containing bile or "inspissated green secretion" developed from hepatic cells (F. T. Paul, 'Trans. Path. Soc.,' vol. xxxvi, p. 238). They are related to adenoma, and are always multiple.

analysed. There was no true pedicle; the attached portion of the cyst was left behind and fixed to the upper part of the abdominal wound. Death occurred in thirty-six hours. All organs were found healthy, even the liver. It is very doubtful if this cyst had anything to do with the bile-ducts in the liver. Langenbuch, relying on the original report in the 'British Medical Journal' (vol. ii, 1874, p. 700), observes that it is not clear that the cyst was not of hydatid origin; but Dr. Goodhart, who examined it when it was mounted as a specimen in the museum of the College of Surgeons (Path. Series No. 2758), could find no hydatid elements in the cyst.

I will now give a short summary of five cases where a unilocular, not hydatid cyst lay inside the liver.

Frederick Bird, of Melbourne, in a case reported by Kilvington, diagnosed a tumour of the liver as not hydatid because the low tension defined by palpation contrasted with that so prominent in hydatid disease. The cyst was opened, fixed to the parietes, and drained. Two years later another developed in the liver, or else the old cyst had filled again. Nothing is said about its contents, but Kilvington includes it under simple cysts which, he states, contain albuminous fluid, and neither bile nor jaundice are mentioned.

Bayer, of Prague, operated on a multiparous woman aged 56, subject to fluctuating swelling in the region of the liver for four months, with pallor, but no jaundice, and irregular action of the bowels. The cyst contained eight litres, or over thirteen and a half pints, of a brownish-grey fluid; it was drained, and fluid, which never contained bile, escaped for some time. A few months after the operation the cavity suppurated, but the patient ultimately did well. Bayer attempts to trace the origin of the cyst to an old and extensive inflammatory process along the gall-ducts, but admits that the pathology of the case was not evident.

Winckler's patient was a woman aged 38. As in Ward Cousins' case, ovarian cystic disease was suspected.

There was no jaundice. The cyst was exposed by an exploratory incision, and eight litres of a glairy yellow fluid were removed. This fluid was highly albuminous, and contained a trace of bile according to Gmelin's test. The cyst wall was of pure connective tissue, from one to two millimetres in thickness, without either glands in its substance or epithelium on its inner surface. The cyst was drained and convalescence was somewhat protracted.

North reports a case where the cause of obstruction was detected after death. The patient was a man aged 45, subject to chronic jaundice. A cystic swelling in the hepatic region was tapped, and five pints of a coffee-coloured fluid were drawn off. The patient died on the second day. A unilocular cyst as big as a man's head was found closely connected with the left lobe of the liver. A calculus of the size of a marble was found impacted in the common duct, and there was a large stone in the gall-bladder. We may agree with Waring that the cavity containing bile in this case must be ranked as a retention cyst, but he notes that the nature of the contents was not made clear.

The fifth case was reported by Mayo Robson. The patient was a woman aged 42, subject to hypertrophic cirrhosis with jaundice. Churton detected fluctuation, and removed six ounces of clear faintly straw-coloured fluid with an aspirator. Two months later Robson opened the cavity with a Paquelin's cautery; about eight ounces of fluid came away. Oozing of blood caused great trouble; it continued for five days, when it ceased, and bile discharged freely from the wound; the jaundice began to disappear. At the end of three weeks local trouble set in with fever, the jaundice remaining stationary. Over a month after the opening of the cyst Robson performed cholecystotomy; there was a large calculus in the gall-bladder which was removed, and two in the common duct. Bile continued to drain from the opening in the cyst, but only a little bile-stained mucus issued from the drainage track which opened into the gall-bladder. The patient

died of pneumonia on returning home; unfortunately there was no post-mortem.

Thus in the cases reported by Bird, Bayer, and Winckler there was neither jaundice nor cholelithiasis; in Winckler's alone was there any trace of bile in the contents of the cyst.

In North and Mayo Robson's cases there was jaundice and obstruction from calculi in the common duct, very definite in North's case. The contents seemed to consist more or less of bile in North's case, whilst in Mayo Robson's bile certainly flowed from the cyst after it was opened.

In my own case there was marked jaundice but no trace of cholelithiasis; the cyst contained pure green bile.

Quite recently Miller of Washington opened and drained a cyst containing five pints of bile, in a girl under three years of age; the abdomen was enlarged at birth. The motions were pale, yet jaundice was absent; after the operation the motions became coloured. Miller considers that the tumour was a congenital dilatation of the gall-bladder and bile ducts, but the tumour occupied part of the liver, the round and suspensory ligaments being attached to its upper surface. Thus Miller's case may be of the same character as my own. I shall refer to it presently in reference to heredity.[1]

Cavities in liver containing gall-stones.—In the cyst which I opened no gall-stones were found, nor did any

[1] Since the above note was made a more complete account of this case has appeared in the 'Amer. Journ. of Obstet.,' vol. xlviii (Aug., 1903), p. 182. Nothing is said about the gall-bladder being defined at the operation, "nothing definite could be determined with regard to the bile-ducts, hepatic artery, or portal vein." The cyst was opened by the thermo-cautery three days after the operation, when it was sutured to the edges of the upper end of the abdominal incision. "The exact nature of the condition is of course open to surmise," but Dr. Brown Miller believes "that the cyst was a tremendous dilatation of the gall-bladder beginning at an early period of intra-uterine life." For reasons given above, I suspect that it might have been, as in my case, entirely intra-hepatic.

come away through the fistula. In Case 22 in Mayo Robson's text-book the gall-bladder was opened and a number of gall-stones were removed; many more calculi were then found lying mixed with semi-purulent fluid in a cavity in the liver substance itself, "having evidently ulcerated through from the gall-bladder." But in the present case the gall-bladder was free from calculi, disease of its coats, or adhesions to the liver. Knowsley Thornton once removed a number of calculi from a cavity in the liver, but I cannot ascertain whether the gall-bladder was in any way involved.

We must remember that the relation of calculi to the intra-hepatic ducts is a question not yet settled. Waring believes that pathological evidence entirely favours the theory that biliary calculi nearly always develop in the gall-bladder. "In most of these cases in which calculi are found in the right or left hepatic ducts, and in the portal fissure of the liver, they have formed in the gall-bladder, and have passed thence into the localities where they have been found. It appears possible, however, in some cases that the calculi have arisen in the commencement of the intra-hepatic bile-ducts." But he has detected an incrustation of bilirubin mixed with lime salts on the walls of the intra-hepatic ducts—a near step surely to the development of calculi. Mr. Peyton Beale informs me that he once performed cholecystotomy for calculi in the gall-bladder and common duct. Two years later the patient died of pneumonia, the liver was found in a spongy state, full of holes, the biggest half an inch in diameter, containing bile; yet it must be noted that though the gall-bladder and common duct had contained calculi none were found in any of these holes—dilated bile-ducts, no doubt, in the liver. On the other hand, Mr. Percy Paton reminds us of a specimen in the Westminster Hospital Museum showing the intra-hepatic ducts much dilated, and containing a large number of stones.[1] He

[1] "581. A slice from an enlarged liver; the bile-ducts are much dilated and filled with inspissated bile, and in some cases with definite pigment

reasonably infers that this condition explains why stones often pass from an abdominal wound when the gall-bladder and the three ducts have recently been cleared of calculi.[1]

Lastly, in my own case there were no calculi either in the liver cyst or outside it. The above cases seem to me worth considering in relation both to bile cysts in the liver and to the development of calculi. The Westminster Hospital specimen seems to prove the theory that gall-stones may originate in the liver, whilst the weight of evidence from the other cases above related is in favour of Waring's opinion that as a rule they begin in the gall-bladder.

Having made some mention of other cases of bile cyst in the liver, I will now dwell on certain more or less essential features in my own case.

The cause: injury or pregnancy?—The history of a blow on the right hypochondrium, nearly three years before the jaundice set in is, to say the least, highly suggestive. It was severe, and abortion followed in a few hours. This blow might have caused the rupture of a duct inside the liver, followed by very slow extravasation of bile into bruised liver-substance around it. A cystic cavity could thus be formed, and ultimately all the bile secreted in the liver might be poured into the cyst. The pressure of the cyst in some way prevented the passage of the bile into the hepatic ducts; possibly, however, a small calculus blocked each of the main ducts which unite in the transverse fissure to form the hepatic duct.

calculi. One of these has been dislodged from its bed, and is stitched to the surrounding liver substance.

"*History.*—The specimen is from a liver which was similarly affected throughout its whole extent. The gall-bladder was full of stones, but was but little dilated. The obstruction was caused by the pressure of a hydatid cyst, about the size of a small orange, which was growing in the portal fissure. *Presented by Mr. Stonham.*" Some of the calculi are quite a quarter of an inch in diameter.

[1] I must add Rolleston's case, "Large Intra-hepatic Calculi in Diabetes," 'Trans. Path. Soc.,' vol. xliv, p. 133, where the gall-bladder and the three ducts "did not contain any calculi and were not dilated." In that respect it was homologous with my own case of bile cyst.

The evidence gained during the operation almost proved that the original seat of disease was entirely inside the liver. The cyst occupied a great part of that organ; the adjacent capsule all over the right lobe was thick and opaque, but did not adhere to any structure, and over the left lobe the capsule was quite transparent. There was absolutely no trace of inflammatory changes around the hepatic, cystic, and common ducts, the gall-bladder and lesser omentum. These familiar structures looked almost diagrammatic, so plainly could they be seen when the liver was drawn well up and forward. There was no thickening of the hepatic duct at the transverse fissure or elsewhere. Nor was there any vestige of omental and intestinal adhesions; the duodenum was perfectly healthy, and the pancreas soft to the touch. In short, though there was an enormous cyst inside the liver, there was no evidence of any disease of the important external structures belonging to it. We know well enough, if we have operated on those parts, how much the ducts and gall-bladder are altered by a very short and moderate inflammatory attack, and the traces of the attack do not tend to disappear when the inflammation subsides. There were no such traces in this case. I feel certain on that account that the cyst was not the result of any disease or injury affecting these parts outside the liver.

Against the theory of injury in my case, it may be urged that blows on the right hypochondrium are common and seldom appear to cause damage to the liver; whilst when they do, that damage is generally rupture involving the fibrous and serous coat. There is of course no absolute proof that the liver was damaged when the patient fell against the washing tub. I must dwell on the fact that pregnancy occurred and went on to term between the date of the accident and the appearance of the jaundice.

In a bad case of obstructive cholangitis of very old standing, where I removed a stone from the common duct,

the acute symptoms dated from a recent pregnancy. Potocki has shown how biliary stasis, common in pregnancy, allows the *Bacillus coli* to ascend the biliary ducts, hence the frequency of cholelithiasis in pregnancy.[1] In the present case there was no such morbid condition in the gall-bladder and the three ducts, but perhaps when the injury which caused abortion was inflicted there was localised biliary stasis due to the pregnancy, whilst the injury caused the rupture of an engorged duct inside the liver.

Potocki would possibly urge that biliary stasis alone caused the development of the cyst during the last pregnancy, after the abortion. But after all the pathologist may contend that the attribution of the cyst to the injury or to changes during pregnancy are pure hypotheses. The cyst may have arisen after the fashion of other bile cysts to which I referred when I dwelt on the general pathology of the subject.

As I have already observed, there were no characteristic symptoms of hypertrophic biliary cirrhosis in this case. The jaundice, usually permanent in that disease, disappeared when the cyst was drained, and the bile could pass into the bowel.

Congenital disease and heredity.—The pathologist may suggest that there was some congenital malformation or disease in the intra-hepatic ducts, the results of which did not, for some reason, develop until adult life. There was no way of getting at any proof of such a condition in my case. The patient's children and near relatives seem never to have suffered from jaundice, or from symptoms of cholelithiasis. In Cocking's case, where the patient was fifty, and had been jaundiced from the age of three weeks, her second child developed jaundice when a month old, had severe epistaxis (a complication from which the jaundiced mother had always been free),

[1] Hence also its greater frequency in women (about five times more common than in men). Some physicians believe that the pressure of stays, etc., on the liver promotes cholelithiasis.

and died in its fifteenth week "with a mottled black and yellow skin." Since I reported a case, already alluded to, of very chronic jaundice, which dated from early girlhood, the patient's eldest child, aged eleven, has suffered from a severe attack, with no symptoms of gall-stones. The patient had four or five attacks, all unaccompanied by pain, before she was eighteen; then for fifteen years there were no hepatic symptoms; at length cholelithiasis set in. In Miller's case the cyst existed at birth, and was drained before the patient was three years old. It clearly was in the liver, and the evidence that it was part of the gall-bladder was defective, as Miller does not state that he determined either the position or the condition of the gall-bladder and the three ducts when he operated. It is easy to conceive that a congenital cyst of this kind might lie latent until adult life. These remarkable clinical facts suggest that overlooked heredity was possible in the present case, whilst local pre-natal or infantile disease with unusually tardy results was quite probable.[1]

The cyst.—The chief feature in this case was the presence of a large unilocular cyst in the liver containing about three pints of normal green bile and no trace of hydatid elements or free blood. The cyst was quite unconnected with the gall-bladder and the three ducts, none of which were obstructed. I regret that I could not excise a piece of the cyst wall for pathological examination, but I did not deem it prudent to do so; the cyst was so completely part and parcel of the liver that when it collapsed I could find no excess of tissue to trim away, and the edges of the incision could just be neatly apposed to those of the wound in the parietes.

The contents of the cyst.—At the operation the cyst

[1] See, for further information on congenital and long-standing jaundice, F. Parkes Weber, "'Simple Persistent' and 'Congenital Persistent' Jaundice, Family Biliary Cirrhosis, and Family Tendency to Jaundice," 'Edin. Med. Journ.,' Aug., 1903, p. 111, an important monograph published since the above was written.

contained over three pints of pure olive-green bile, two and a half pints being removed at once and sixteen ounces a few hours later. According to Copeman and Winston olive-green is the normal colour of bile.

Out of the five cases of liver cyst above related, in Mayo Robson's alone did the cavity discharge bile, whilst when first opened the fluid was clear, and there were calculi in the gall-bladder and the common duct.

Jaundice.—This symptom was marked in my case, but why it appeared suddenly four months before operation I cannot explain. It began to subside when the bile flowed freely out of the drainage track after the operation, but the bile did not colour the fæces until the fourth week. Thus some obstruction must have existed till that date, although the pressure of three pints of bile had been removed at the operation. The cyst probably pressed on the ducts or set up catarrh in them, as has been observed when jaundice is associated with hydatid cysts (Waring). Perhaps catarrh existed in my case, and did not subside until the fourth week; but the three ducts looked very healthy at the operation, so that it must have been the radicles of the hepatic duct that continued to be obstructed for a while by catarrh or some other cause.

The experiences of Bayer and Winckler, as well as the familiar instance of hydatid disease, show that large intra-hepatic cysts are not necessarily associated with jaundice.

Hæmorrhage in jaundice.—Petechiæ were very conspicuous on the trunk. Menstruation continued quite regular during the jaundice, but the show of blood was diminished, not increased; the period appeared, with moderate show, on the second day after operation. In Cocking's case the patient, aged 50, and jaundiced from infancy, had never suffered from hæmorrhages at labour, nor at the catamenial period, which was always regular, nor after the extraction of teeth.

How far the moderate doses of chloride of calcium benefited my patient I cannot say. I had not the least trouble

from hæmorrhage during the operation. The dressings over the drainage-tube were over-saturated with deep green bile for nearly a week, and had to be changed three times a day at first, though the cyst was emptied night and morning by means of a syringe. Yet these dressings showed but little blood-staining. No chloride of calcium was given after the operation. This absence of any tendency to hæmorrhage was marked in a very different case of deep jaundice to which I have already referred. When I operated in the spring of 1902 the cause was obstruction of the common duct by a single calculus, with severe cholangitis and high temperature. In this case, as in that now reported, there were petechiæ; the catamenia were also regular and moderate; chloride of calcium was given before operation, but not afterwards, and there was no subsequent trouble from oozing.

Some authorities may think that the chloride of calcium had nothing to do with the freedom from hæmorrhage observed in both these cases, but Mr. Mayo Robson might hold, on the other hand, that I ran a considerable risk in not administering that salt after as well as before the operation. In his case of jaundice with liver cyst which discharged bile when it was opened the subsequent oozing gave great trouble. More recently before this Society the same authority related how almost uncontrollable oozing occurred on the second day after choledochotomy in a case where jaundice was severe; it ceased when the chloride of calcium was resumed.

Lastly, tendency to hæmorrhage is most marked in chronic obstruction of the common duct with coincident disease of the pancreas (Stewart of Philadelphia), complications which did not exist in my case.

Hæmorrhage into the cyst.—No trace of blood could be detected in the bile removed during the operation, and little, if any, in the bile which drained away from the wound afterwards; in short, there was no hæmorrhage into the cyst. It is evident, however, that a patient who walks

about with a cyst containing three pints of fluid is liable to that complication.

Kilvington, in a monograph on simple cysts of the liver, which he finds contain fluid usually albuminous, relates a case under the care of Allen, of Melbourne, in order to show that hæmorrhage into large cysts may prove fatal. Allen's patient was a young woman found in a railway waiting-room in a state of collapse. She died shortly afterwards, and a large cyst full of blood was discovered in the liver. Minute hæmorrhages, Kilvington observes, are of frequent occurrence even in tiny cysts. I cannot find a more complete report of Allen's case; I presume that it was not hydatid and did not contain any elements of bile, else it would not have come under the scope of Kilvington's observations.

The question of hydatid disease.—The total absence of hydatid membranes in this large cyst, and the fact that the pure green bile which it contained was free from any trace of microscopical elements of hydatid cysts, make it highly improbable that the cyst was a product of hydatid disease. Bile may enter a hydatid cyst in the liver through communication with the gall-bladder or the three ducts due to inflammatory processes; even a lumbricus has found its way into a hydatid cyst in this manner (Treichs, quoted by Langenbuch). This leakage kills the parasite, and the cyst either shrivels up or suppurates; in rare instances the parasite has survived (Waring). But there were no adhesions in my case to the gall-bladder or the three ducts, and supposing that we assume that the cyst was hydatid, and that an intra-hepatic duct burst into it, how could we make out that the bile or some other agent cleared away all traces of acephalocysts, hooklets, etc.? In fact, all clinical and pathological evidence was against the existence of hydatid disease.

Menstruation. The catamenia had been regular during the existence of the jaundice, but scantier than before the illness. They appeared on the second day after the operation; the show of blood was distinct but slight.

Cocking's case shows that a woman may menstruate regularly and bear children although subject to jaundice from infancy. Jaundice we know does not necessarily cause menorrhagia, nor does amenorrhœa seem to be the rule; when present it is most likely the result of ill-health or anæmia. In Mayo Robson's case of biliary fistula[1] menstruation was suppressed, but returned as soon as the course of the bile was successfully directed into the bowel by an operation.

The treatment.—The drainage of the cyst was clearly indicated, nor did any further procedure appear to be called for when I operated. The result was most satisfactory. By the fourth week, when bile began to pass into the bowel, the chances that a second operation to establish a communication between the cyst and the bowel would be necessary became remote.

It is not remarkable that suppuration has occurred in the track, which is not likely to become obliterated for some time, as the hepatic tissue cannot readily close in around a cavity so capacious. In Bayer's case an abscess developed a few months after the operation; probably the drainage track was allowed to close too soon. Infection from sutures is difficult to avoid when a big liver cyst is drained.

We must agree with Kilvington that the curette should never be used; there is usually no epithelium lining big cysts that could secrete so as to fill the cyst again. That writer recommends that a simple cyst should be dropped back when all the fluid has been allowed to escape, but he adds that when calcareous plates are present, or when there is any bile in the fluid, drainage is necessary. Of course, dropping back the cyst, or rather the liver with the big cystic cavity inside it, would have been out of the question in the present case.

In conclusion, I think that the total absence of any symptoms of shock after this operation is instructive.

[1] In Noel Paton and Balfour's case the patient had passed the menopause.

The common opinion that an operation on the upper part of the abdominal cavity necessarily involves shock is quite untrue. The alarming symptoms sometimes observed seem distinctly due to prolonged handling of the pancreas, duodenum, great vessels, and nerve plexuses. In the days when incisions were made very short the operator's fingers, working in the dark, must often have bruised these important structures. Now that the parts are freely exposed to the operator's eyes much less handling is needed. In this case I could see everything, and the parts involved in chronic cholelithiasis were all free from disease. The liver itself bears handling very well.

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DISCUSSION.

Mr. W. BRUCE CLARKE considered that Mr. Alban Doran had left his view of the pathology of this case a little obscure. It was either dependent on the injury, or it was a retention cyst or a congenital cyst. More probably the injury was the cause. A somewhat analogous case was that of a man whom he had had under his own care and who suffered from hydronephrosis and had epileptic fits as well. During a fit he fell and struck his side on a hard object, with great collapse ensuing. This passed off, but it was noticed that the kidney had become increased in size, and some six weeks later, when the kidney was operated on, it was found that a renal vein had ruptured into the hydronephrotic cyst, and the blood had separated into clot and fluid. Traumatic hydronephrosis, too, was to some extent parallel with the suggested ætiology. Dr. Miller's case, which Mr. Doran quoted, was in a child of three or four years of age, and was thus hardly comparable with the present case. The jaundice in the present case was probably due to obstruction by pressure, and catarrh of the ducts probably prevented the flow of the bile after the operation when the pressure had been relieved. The connection of this case with mobility of the kidney was interesting, and the mobility was probably directly due to the liver cyst. The diagnosis lay between a hydatid cyst, a simple cyst, and a cyst connected with malignant disease. Except for the duration of the case there was no symptom or sign that could differentiate these conditions.

Mr. A. C. BUTLER-SMYTHE referred to the difficulty of diagnosis in the present case. He had seen the patient before operation, and had formed the opinion that there was probably a large distension of the gall-bladder. With regard to the nature of the cyst, he thought that the diagnosis might have been settled by cutting off a portion of the wall of the cyst at the time of the operation. The gall-bladder and the ducts were greatly pressed upon by the cyst, and he thought that the jaundice was probably more due to mechanical obstruction than to actual obliteration of the ducts. With regard to the movable kidney which was present on the right side, he was of opinion that the right kidney could in a large majority of cases be felt

in a woman who had had more than one pregnancy. He did not consider that the administration of chloride of calcium had much effect in preventing the occurrence of hæmorrhage. In his opinion the flow of bile coming on soon after the operation eliminated the theory of a calculus as a cause of the trouble, and it was an undecided point whether the liver substance had been injured or not.

The PRESIDENT referred to the non-appearance of the flow of bile after the operation, and suggested it might be explained by the fact that a large bile-duct opened into the cyst, and that the readiest course for the bile was through the cyst, so that it was not until the cyst began to contract that the bile began to flow along its normal track.

Mr. ALBAN DORAN, in reply, said that he considered the explanation given by the President highly probable. In support of the traumatic theory of origin dwelt on by Mr. Bruce Clarke he instanced the case of a boy who, while romping, was struck in the right hypochondrium. There followed great increase in the area of the hepatic dulness, and a fortnight later there came on evidence of acute anæmia and he died; this he considered suggested the formation of a blood-cyst in the liver. There was no evidence whatever of calculus in the case described in his paper. Mr. Doran had hinted that a congenital origin of the cyst was just possible though hardly probable. Congenital malformations sometimes remained latent in childhood yet underwent active changes in adult life.

REMARKS ON FIFTY CONSECUTIVE CASES

OF

PERFORATED GASTRIC AND DUODENAL ULCER

TREATED BY LAPAROTOMY

BY

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The fiftieth operation at St. George's Hospital for perforation of a gastric or duodenal ulcer was performed in June of this year. Having had the opportunity of observing and taking notes of the majority of these cases during the last six years, I thought that it would be interesting to review the cases as a whole, especially in regard to certain points, such as the question of premonitory symptoms, the incidence of complications, and the after results. For permission to use the cases, I am greatly indebted to the physicians and surgeons under whose care they came.

Few subjects have attracted more attention during the

past few years than the condition of perforated gastric or duodenal ulcer; and the number of recorded cases is now very large. In a condition of this kind, the operative treatment of which is comparatively new, it is important that cases should be reported systematically, and it is unfortunate that more use cannot be made of the vast amount of material available in the wards of the large general hospitals. Cases of the greatest interest are relegated to the hospital 'Reports,' if such are published, or more often remain in the hospital case-books, and are buried in oblivion. The value of hospital statistics, faithfully recorded, is obvious. A long series of consecutive cases, which includes the failures as well as the successes, the unfortunate cases as well as the surgical triumphs, cannot fail to give more accurate information than a collection of cases from the medical journals. It is notorious that the ways of human nature are such that the cases which find their way into the medical press are conspicuous by the absence of the correct proportion of failures. A series such as the present one possesses further value in that it represents the practices of many surgeons, and the results of widely different methods.

In this paper, which I have the honour to read before you to-night, acute perforations of duodenal ulcers have been grouped with those of gastric ulcers, as the general aspect of the cases is very similar; on the other hand, an entirely different clinical picture results with subacute or chronic perforation, and no cases of this nature are included in the series. Three cases have been admitted into hospital in which no operation was performed, owing to the condition of the patient being too desperate for surgical interference; and in two instances patients were brought in dead, death having speedily occurred during the initial shock. In these latter cases the rent in the stomach wall was large, and the peritoneal cavity flooded with material from the stomach.

In these fifty consecutive cases the stomach was the seat of perforation in forty-two cases, and the duodenum

in eight cases. In the cases of perforated gastric ulcers, thirty-three occurred in females, the average age being 26·4, and nine in males, with an average age of 37·3; twenty-two, or 52 per cent., of these patients recovered. In the duodenal perforations two occurred in females, the ages being 22 and 27 respectively; and six occurred in males, the average age being 34·6: two only of the eight cases recovered. The total mortality is therefore 52 per cent. These results are very encouraging, more especially as it is found that the mortality is steadily diminishing. Three out of the first ten cases recovered, whilst of the seven cases admitted during the present year six have recovered. This improvement is doubtless due to the earlier recognition of the condition, to earlier operations, and to the greater care expended in the cleansing of the peritoneal cavity.

The first operation of this nature at St. George's Hospital was performed in December, 1892, although several cases of subphrenic abscess had been surgically treated before this date. The case presents several points of interest. The patient was a parlourmaid, aged twenty-six, and the abdomen was opened fourteen hours after the onset of symptoms. A perforation of the stomach was found in the centre of an area of dense induration three inches in diameter. Invagination of the perforation was impossible, and excision equally out of the question; the abdomen was therefore irrigated and the perforation attached to the upper part of the wound, a drainage-tube being inserted. Bilateral parotitis developed during the first week after operation, and suppuration occurred in both glands. Pulmonary symptoms developed later, and the left lung was explored, with a negative result. The patient survived until the forty-third day after operation, and at the autopsy a small abscess was found between the base of the left lung and the diaphragm.

The first successful case occurred in April, 1894. The patient was a female aged forty-one, and the perforation a small one in a chronic ulcer near the pylorus.

The question of premonitory symptoms is one of the highest importance, for it is found that in a certain proportion of the cases premonitory symptoms do occur, although they are hard to recognise. My attention was more especially drawn to this point by having seen three patients in whom perforation occurred whilst they were under treatment in hospital. In order to gain further information on this point I analysed, firstly, the previous history; and secondly, the symptoms immediately preceding perforation.

In regard to the first point I found the following results:—In five cases there was no history of previous gastric trouble of any kind; in thirty-four cases there had been definite dyspepsia or gastric ulceration, hæmatemesis having occurred in eight of these cases. In six cases it was stated that though there had once been dyspepsia, this had not existed for some time before perforation; in five cases no information is given on the point. In 22 per cent., therefore, symptoms had been completely latent before the actual rupture; whilst in many of the others the dyspepsia had been of a slight nature, not requiring any serious medical treatment.

A study of the symptoms immediately preceding the onset of the violent pain characteristic of the moment of perforation is of more importance. As is well known, in the great majority of cases the onset is sudden and without warning. In ten of the cases, however, this was not so, the condition then usually being progressive increase of pain and vomiting for a short period before perforation, this period being sometimes a few hours, sometimes two or three days. In one case hæmatemesis had occurred four times in the preceding three weeks. In another case the patient had just come to the out-patient department to be treated for gastric ulcer, and was waiting at the dispensary for her medicine when perforation occurred. A second case in which hæmatemesis preceded perforation is referred to below. The comparative rareness of this association is probably due to the careful treatment to

which patients recovering from hæmatemesis are subjected.

In ten cases I made inquiries as to the *menstrual history* of the patient, but found no evidence that perforation is more likely to occur shortly before and during menstruation than at any other period; in two cases only did the conditions coincide. Hæmatemesis, on the other hand, undoubtedly is more frequent just before the onset of menstruation, a fact which is probably explained by the higher blood-pressure at this time.

The cases in which perforation occurred in hospital must be referred to in greater detail. All three patients were men, and the similarity in the cases is very striking.

The first patient was a bootmaker, aged 48. He had suffered from dyspepsia for twelve years, and for the six months before admission there had been severe epigastric pain with frequent vomiting and rapid loss of weight. On admission the stomach was greatly dilated, and there was marked epigastric tenderness. During the first two days there was moderate pain but no vomiting; on the third day the pain was worse, and vomiting occurred twice; on the fourth day the pain was less, but there was more superficial tenderness in the epigastrium; during the evening of this day the pain gradually became worse, and then suddenly the patient was seized with the most intense pain and became extremely collapsed. Six hours later a ragged irregular perforation on the anterior surface of the stomach close to the pylorus was sutured. Progress was satisfactory until the eleventh day after operation, when profuse melæna set in, and death occurred on the fifteenth day. The autopsy showed that a duodenal ulcer had perforated the gastro-duodenal artery.

The second case was that of a man aged 37, who had been sent to hospital as a case of carcinoma of the pylorus. There was marked dilatation of the stomach, and an irregular mass in the right hypochondrium. The patient was quite comfortable except after taking food, which caused pain and usually vomiting. Tenderness over the swelling

was present throughout. On the evening of the third day symptoms of perforation occurred, followed by great collapse and death a few hours later. The lesion proved to be a large chronic ulcer, with a small perforation on the lesser curvature.

The third case occurred three months ago; this patient, aged 63, was also supposed to be the subject of carcinoma of the pylorus. There had been much pain after food for six months, with rapid loss of weight, and vomiting characteristic of dilatation of the stomach for a month. On admission there was superficial tenderness over the upper part of the right rectus muscle, and gastric peristalsis extending to a line one and a half inches below the umbilicus. On the second day there was constant pain, aggravated by milk and soup. On the third day, forty-four hours after admission, a sudden attack of hæmatemesis occurred, a pint of dark blood and clots being vomited. Nine hours later, whilst the man was reading a newspaper, sudden agonising pain occurred in the right hypochondriac and scapular regions. The signs of perforation were obvious, and the abdomen was opened two hours later; a small pin-hole perforation in the floor of a large pyloric ulcer was found, but unfortunately the patient died of syncope at the close of the operation.

A careful study of these cases leads us to the following *conclusions*:—Premonitory symptoms are most likely to occur in cases of chronic and marked ulceration; such symptoms are progressive increase in discomfort and pain after taking food of any kind, greater frequency of vomiting, and increase of the surface and deep tenderness in the epigastrium. When such conditions are found, active and deep ulceration with the danger of perforation should at once be suspected, and no food of any kind should be administered by the mouth. The patient should be kept quiet in bed, and morphia especially should be avoided owing to the danger of masking the symptoms of perforation, should this occur.

In regard to *symptoms* of perforation, the onset was

abrupt in the great majority of cases, the patient being occupied with the ordinary duties of life at the time of perforation. In several instances rupture had been determined by some extra exertion or the ingestion of food; in one case vomiting had occurred just before. On the other hand, in nine cases perforation occurred whilst the patient was in bed. The severity of the initial pain is almost constant, and highly characteristic of perforation. This sudden, terrible, intolerable pain is rarely met with in any other condition, and cannot in its full intensity be simulated by neurotic subjects. Although as a general rule we must rely rather on what we see than on what we hear in these cases, a history of pain of this character appears to be of real value in forming a diagnosis. The situation of the pain is no guide to the situation of the lesion. In perforations of the stomach the pain is often most intense in the lower part of the abdomen, the gush of stomach contents falling towards the pelvis. It is notorious that in many cases of perforated duodenal ulcer the pain is most marked in the right iliac fossa, and acute appendicitis is closely simulated. The intensity of the collapse was found to bear a fairly constant relation to the size of the perforation; and similarly, the larger the tear the more free gas in the peritoneal cavity.

Somewhat discordant statements have been made as to the frequency with which *vomiting* forms one of the symptoms of perforation. One well-known authority states that vomiting is usually absent, whilst others have suggested that it is a mechanical impossibility if the rent is at all large; Finney found it recorded in 40 per cent. of the cases, and Fenwick in 29 per cent. In the present series vomiting occurred in thirty-seven cases, was absent in ten, and was not mentioned in three; in other words, it was present in 79 per cent. of the gastric cases, and in 75 per cent. of the duodenal cases. Generally speaking, it occurred shortly after perforation in the majority of cases, and did not recur after the first few hours. In five instances, however, vomiting did not take place until

an interval of two hours or more after the onset of the primary pain. Further, it was usually noticed that in the fatal cases, in which vomiting had been absent for some hours before operation, it reappeared and persisted after recovery from the anæsthetic.

The stage of reaction following the stage of collapse was met with in a large number of the cases. The degree of reaction varied, but it was often well marked, and then latency of symptoms formed a prominent feature. The primary collapse was recovered from, the pain subsided, the vomiting ceased, and two of the patients even walked into the hospital with their peritoneal cavities bathed in gastric contents; occasionally the pulse became normal in frequency and tension, the temperature normal, and no unusual physical signs were discoverable in the abdomen. This period has been well described as the *quiescent period*, or the period of repose, and should the true state of affairs not be grasped, disaster may follow. If the patient is first seen in this stage, as frequently happens, a serious view may not be taken of the case, and a fatal delay may result. The treacherous calm is followed by storm, the acute symptoms return, and the presence of acute peritonitis becomes unmistakable. Numerous instances might be related of this. The following two cases, however, will illustrate the condition well.

A man aged 36 walked into St. George's Hospital complaining of "stomach-ache," which he attributed to having eaten half a pound of unripe cherries on the previous evening. The pain had come on suddenly two hours before he came to hospital, and had been severe and accompanied by vomiting. When seen his general condition was perfectly good. He complained of slight colicky pain about the umbilicus; the pulse was 76, temp. 98·4°, and the abdomen soft, without tenderness or rigidity. He was admitted and carefully watched. Slowly but progressively the pulse increased in frequency—a point of especial importance. At 6 p.m. it was 96; at 10 p.m. 110; at midnight 116; and at 2 a.m. 128. The abdomen

became board-like and tender, and vomiting returned. Laparotomy was performed, revealing a perforated duodenal ulcer with early general peritonitis; the perforation was sutured, the peritoneum cleansed, and the man made an excellent recovery.

The other case was that of a young girl aged 22, who was sent up to hospital with a history of sudden abdominal pain and collapse without vomiting. On admission, there was nothing in her appearance to suggest that she was ill. Her pulse was 72 and of good quality, her temp. 98·6°, and the abdomen presented no tenderness, rigidity, distension, or abnormality on percussion. A few hours later her pulse became more frequent, and the abdomen tender and board-like. Laparotomy was performed, and a perforated gastric ulcer found.

Having thus emphasised the latency of symptoms during the period of reaction, the next point which I wish to raise is *the effect of stimulants in producing temporary improvement* in the patient's condition, and in masking the gravity of the case. The quiescent period of course occurs quite apart from the administration of morphia or stimulants, although these measures naturally intensify it. The action of morphia in this respect is universally known, but I believe that stimulants will produce a similar deceptive improvement, especially in the form of the large doses of brandy so often administered by sympathetic relations and friends. In the second case, which I have just described, the medical man had injected 12 minims of strychnine owing to the profound collapse in which he had found the patient. This treatment was undoubtedly beneficial, but, I think, contributed largely to the complete quiescence of symptoms observed a few hours later.

The condition of the hepatic dulness appears to be inseparably connected with the notes of cases of this kind. It forms an obvious and striking physical sign, but experience shows that it is of comparatively little value, and likely to mislead if relied upon. It has been weighed in

the balance and found wanting. Cases of uncomplicated gastric ulcer without any distension of the abdomen have been published in which the liver dulness has been completely absent, and in which laparotomy has proved that no perforation existed. The condition of the liver dulness is definitely stated in forty-three of the cases; it was normal in eleven cases, completely absent in twelve, and diminished in twenty cases. In several instances in which it was diminished this change was found to be limited by the falciform ligament, and then dulness was more often absent to the left than to the right of the ligament. It has been suggested that loss of the hepatic dulness as far back as the mid-axillary line can only be produced by the presence of free gas in the peritoneal cavity, not by other conditions such as distended intestine. In order to test the accuracy of this statement I carefully examined the liver dulness in ten cases of perforation; in seven of these it was diminished or absent, and in four of the cases this diminution extended to the mid-axillary line. On the other hand, I found a similar condition in two cases in which the abdomen was opened but no perforation found. This sign, therefore, seems equally unreliable.

The exact cause of this change in the liver dulness, when not due to the presence of free gas in the peritoneal cavity, is extremely difficult to explain, and several theories have been advanced. It seems unlikely that the distended colon can often lie actually in front of the liver, for it is very rare at autopsies of any kind to find intestine between the liver and the anterior abdominal wall; in one of the fatal cases in this series, however, in which liver dulness was noted as absent before operation, the colon was found in front of and considerably compressing the right lobe of the liver.

It has been stated that the presence of a well-marked area of stomach resonance in the left hypochondrium contra-indicates perforation of the stomach. It was, however, frequently noted during the operation that the

stomach was distended with gas, and sometimes greatly distended when the perforation was small or valvular. The extent of gastric resonance is therefore of no diagnostic value.

I may here mention that in two cases seen shortly after perforation I was struck by the fact that sweating, though present over other parts, was more intense by far over the epigastrium.

The situation of the perforation is shown in the accompanying diagram. During operation it is often very

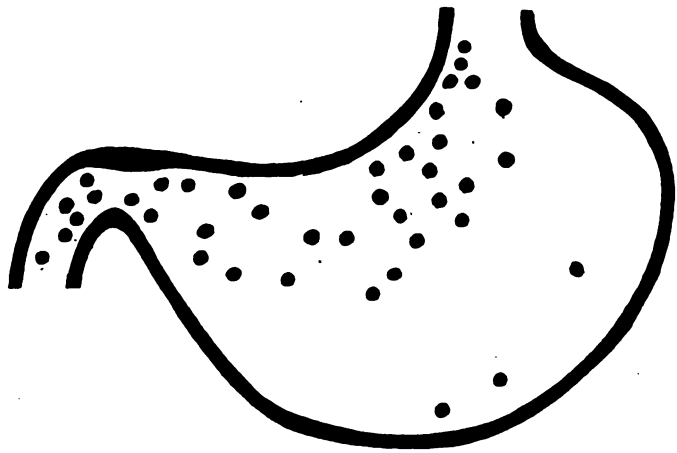

Diagram showing situation of ulcers on anterior wall of stomach and duodenum.

difficult to be certain as to the exact position of the ulcer, more especially when there are many adhesions or much lymph around; and discrepancies upon this point are frequently found in the accounts of the operations and the post-mortem reports. The diagram shows that perforations most commonly take place in ulcers situated close to the lesser curvature, and are rather more frequent towards the cardiac than the pyloric end of the stomach. On the other hand, perforating ulcers close to the greater curvature are comparatively rare. Five of the ulcers

occurred on the posterior wall, close to the pylorus; the rents were usually large, and the gastric contents had escaped through the foramen of Winslow into the greater sac of the peritoneum. The duodenal perforations all occurred in the first part of the duodenum, six on the anterior wall, and two on the upper and posterior wall.

The number of instances in which perforated duodenal ulcers have been successfully sutured is still so small that details of two cases in this series may here be referred to. The first case has already been mentioned as an example of the "latent period," or period of repose; it has been published in detail elsewhere. The second case occurred in a female aged 22, with a history of old but not recent indigestion. Eight hours after taking some aperient pills she was suddenly seized with agonising pain, felt at first in the right hypochondrium, and later spreading over the entire abdomen. She felt sick, but no vomiting occurred. The pain continued, and morphia was given; the bowels acted scantily after an enema on the third day, when she was admitted into hospital. Her condition was then masked by morphia; pain was referred vaguely to the right side; the abdomen was hard, rigid, and tympanitic all over, immobile, but not much distended; liver dulness diminished. Laparotomy was performed about sixty-eight hours after the onset of symptoms, and free gas with foodstuffs found in the peritoneal cavity. A small perforation in the first part of the duodenum was discovered, and occluded by a purse-string suture, strengthened by four Lembert stitches. The peritoneum was thoroughly irrigated, and she was discharged four weeks later after an uneventful convalescence.

The possibility of saving the patient's life even in the most desperate cases is further illustrated by a case in which a perforated gastric ulcer was successfully treated seventy-two hours after the onset of symptoms. The case is a remarkable one, for there was intense general peritonitis, and the patient's condition before operation was

so precarious that surgical interference seemed scarcely justifiable.

The incidence of complications arising after operation will next be discussed. Of the twenty-four cases which recovered definite complications occurred after operation in thirteen; whilst in the fatal cases, which survived the first twenty-four hours after operation, complications developed in eight. The two cases in which perforated duodenal ulcers were successfully sutured recovered without complications; empyema was present in one of the fatal cases. It appears that in more than half of the successful cases complications may be expected during the period of convalescence; and further that complications are often multiple, and are more commonly noticed after than during the first week.

Inflammation of the parotid gland occurred in five cases, being bilateral in two, and involving the gland on the left side in the other three. It was first noticed on the second, third, fifth, sixth, and sixteenth days respectively, and in the bilateral cases the onset of inflammation on the two sides was separated by an interval of two days. Suppuration—a very unusual event in these cases—occurred in both glands in the first case operated upon at St. George's Hospital; the right parotid had become inflamed on the second day, the left on the fourth day, and pus discharged from both ears on the ninth day. Incisions were made, and the resulting sinuses persisted until death six weeks later.

No definite relation to the absence of feeding by the mouth is noticed, three of the patients in whom this complication occurred having had food by the mouth for more than twenty-four hours. Mr. B. N. Tebbs, of St. George's Hospital, has very kindly given me figures relating to the incidence of non-specific parotitis. Of thirty-two cases occurring in this hospital during the last ten years twenty-one followed operation upon, or disease of, the stomach.

Uncomplicated gastric ulcer .	11 cases.
Perforated gastric ulcer . .	5 „
Excision of gastric ulcer . .	1 case.
Gastrostomy, gastro-enterostomy, etc.	4 cases.
	21 cases.

Pleurisy is by far the commonest complication, occurring in six of the successful cases, and being found in eleven of the twenty-one cases in which the chest was examined post mortem. As would be expected, the left side was most commonly involved; the actual figures are —both sides five cases; left side ten cases; right side two cases. The pleurisy was usually of the dry fibrinous variety (eleven cases), and limited to the diaphragmatic area. In two fatal cases, however, an empyema was present. It seems probable that the pleurisy is often due to the transmission of toxic products through the diaphragm, and not to the presence of micro-organisms, for the effused fluid is usually sterile, and empyema is uncommon. This is illustrated by a case which occurred two years ago.

The patient was a female aged 23. On the fifth day after operation friction was heard in the left lower axillary region; this was followed by signs of effusion into the pleural cavity, and on the eleventh day the pleura was aspirated and ℥xxj of serous fluid withdrawn. Microscopically this was found to contain a very large number of highly active leucocytes, whilst cultures made from the fluid proved absolutely sterile. The temperature remained high and irregular, and rigors occurred; an empyema was suspected and the pleural cavity opened in the mid-axillary line on the sixteenth day. Only clear fluid, however, was found, and so the diaphragm was punctured. This led to the discovery of a large subdiaphragmatic abscess, containing a quantity of very foul pus.

Amongst the *other complications* are the following:— *Thrombosis* occurred in three cases, the left external

saphena vein being involved twice, and the deep veins of the left leg in the other case; the symptom was first noticed on the fourteenth, sixteenth, and seventeenth days respectively. Severe *hæmatemesis* occurred in three cases, two of which ended fatally; death in one case was due to blood inhalation during vomiting, the trachea and bronchi being found full of blood post mortem. Reference has already been made to a case in which severe hæmorrhage from perforation of the gastro-duodenal artery by a duodenal ulcer proved fatal eleven days after successful suture of a perforated gastric ulcer. *Hæmaturia and albuminuria* were noticed on the seventh day in a female aged twenty-eight, although as far as could be ascertained this condition had not existed before. Albumen and renal casts with a few pus-cells were present in the urine for six weeks, at the end of which time the urine became normal.

All the symptoms and physical signs of perforation may be presented, and yet the stomach may be found intact when the abdomen is opened. Such cases must occur in the practice of any hospital or of any surgeon of experience, for undoubtedly the correct treatment is to explore whenever perforation is suspected. A small incision above the umbilicus will at once decide the question, and involves practically no risk in itself, whilst a few hours of delay may be sufficient to make operation futile. These cases may be divided into two classes,—those in which some other peritoneal lesion is found, and those in which nothing abnormal is discovered.

I have the notes of seven such cases. All the cases occurred in young females with histories of gastric trouble; the symptoms and signs pointed to perforation of the stomach, and operation proved that this had not occurred. In three cases no abnormality of any kind was discovered; one case was especially interesting, as she was admitted at exactly the same time as another patient with exactly identical symptoms, which proved in the latter case to be due to a perforated gastric ulcer. Another

patient, a highly neurotic woman of twenty-eight, who had already had laparotomy performed twice, had apparently acquired a lust for the surgeon's knife, and was admitted in the middle of the night with acute abdominal symptoms. In the fourth case nothing was discovered beyond some blood-stained œdema of the gastric attachment of the omentum. In the fifth case the peritoneal cavity contained blood-stained fluid; the pelvis was examined through a second incision, and apparently rupture of a small ovarian cyst was the cause of the condition. The sixth and seventh cases proved fatal. In one the abdomen was full of odourless turbid serum, and a most careful search failed to reveal the source of the infection; the stomach was most certainly intact; no autopsy was performed. The other was a case of acute appendicitis with general peritonitis, in a young dyspeptic girl, in whom all the physical signs were most intense in the epigastric region. The reverse condition of course is more common, namely, the simulation of appendicitis by a perforation of the pyloric end of the stomach or duodenum, owing to the downward gush of fluid, and in four cases in this series the primary incision was made over the appendix region.

It is interesting to note that in two of the three cases, in which there was no intra-abdominal lesion, the symptoms occurred shortly before the onset of the menstrual period. I have seen several other cases in which neurotic women have presented acute abdominal symptoms at this time; the clinical picture of perforated gastric ulcer may be closely simulated, but, generally speaking, there is not the severe collapse and intense pain at the outset, and constitutional disturbance is not so marked. The symptoms clear up with the onset of menstruation. It would be interesting to hear of other cases of this nature.

The frequency with which ulcers are present in other parts of the stomach or duodenum is well illustrated by examination of the fatal cases. In thirteen of the twenty-one cases in which autopsies were performed other peptic

ulcers were present, and it is quite possible that small ulcers may have been overlooked. In two instances four ulcers were present, in addition to the one which had perforated. Their most common situation was exactly opposite the perforated ulcer. Although no cases of double perforation occurred, in one instance a second acute ulcer of the perforating type was found to have reached the peritoneal coat of the stomach.

In regard to the details of the operations it is found that general irrigation of the peritoneal cavity was employed in thirty-one cases, local irrigation in nine cases, and in the remainder sponging only was relied upon; with each of the three methods the mortality was the same, namely, about 50 per cent. A further point brought out by a study of the cases is the *increasing tendency to dispense with drainage.* This is a question upon which surgeons differ greatly, and one well worthy of discussion.

The difficulty in securely closing the perforation in deeply seated ulcers was frequently found to be diminished by the preliminary separation of adhesions to the liver and surrounding parts, and by the use of cleft palate needles; the line of suture was strengthened in six cases by omental grafts or plugs, and in three cases by a similar use of masses of lymph. In a case in which the perforation was deeply placed near the œsophageal opening, and stitching was impossible owing to the friability of the surrounding gastric wall, strips of gauze were passed down to the ulcer; no further escape of gastric contents occurred, and an uneventful recovery followed.

In conclusion reference must be made to the *after condition of the patients.* Do the symptoms of gastric ulcer recur, or is the patient cured by the operation? The question is one of practical importance, for certain authorities recommend that a posterior gastro-enterostomy should be performed after the perforated ulcer has been dealt with, if the patient's condition will bear it. This operation would be exceedingly difficult, or perhaps im-

possible, if attempted at a later date, and so it is urged that it should be done at once in order to complete the patient's cure. Regarding the matter from a theoretical point of view, we might expect the symptoms of ulceration to recur if the perforation be simply sutured. These ulcers are known to be usually multiple, and the local conditions which favour ulceration still exist. In practice we find that this is not the case; the after results are surprisingly good. During the last summer I have written to each of the twenty-four successful cases. An investigation of this kind is always difficult, for hospital patients of all kinds, and domestic servants in particular, are constantly changing their address, and so are readily lost sight of. I was able, however, to trace seventeen of the twenty-four patients. The reports of these cases may be summarised as follows:—In eleven cases there had been no return of gastric symptoms of any kind, and the patients had been quite well since operation. Two had married and had had children. In four cases dyspeptic symptoms were complained of, two being readmitted into hospital for short periods. The point which I wish to emphasise here is that the symptoms were characteristic of dyspepsia, and not of gastric ulcer; the pain was of a dull, aching, diffuse character, and in no case was there vomiting or hæmatemesis.

One patient came under treatment one and a half years after operation for œdema and superficial varicose veins of the leg; this case had been complicated by thrombosis, and was satisfactorily treated by an elastic stocking: there were no gastric symptoms. Another patient was recently seen seven years after operation. She was suffering from congestive dysmenorrhœa, and the pelvic organs were found to be extensively matted by firm adhesions; slight peristalsis of the intestinal coils was also visible through the abdominal wall. She had been married for five years, and was sterile. It seems highly probable that in this case the pelvic peritonitis, with the

subsequent dysmenorrhœa and sterility, dated from the gastric perforation.

The number of cases is small, but the results point conclusively to the fact that the great majority of the patients are cured of their gastric ulcers if they survive the primary operation. Dyspeptic symptoms occur in a small proportion of cases, and are readily amenable to medical treatment. Gastro-enterostomy is therefore unnecessary; in any case there are many arguments against its immediate use in cases of perforation. It materially increases the duration of the operation, and rapidity is essential if the patient is to have her best chance. In itself the operation involves an increased risk; the parts are in the worst possible condition for a complicated plastic operation; and finally, as we have said, it is unnecessary. I have already referred to a patient who died of hæmorrhage from a duodenal ulcer on the fifteenth day after suture of a ruptured gastric ulcer. In this case it is possible that a gastro-enterostomy might have checked the progress of the duodenal ulcer and prevented the fatal hæmorrhage; but the case is quite an exceptional one, and forms no argument for the routine performance of gastro-enterostomy.

TABLE I.—*Fifty Consecutive Cases of Perforated Gastric and Duodenal Ulcer at St. George's Hospital.*

	Gastric Ulcer.		Duodenal Ulcer.	
	Cases.	Recovered.	Cases.	Recovered.
1892	1	0	—	—
1893	1	0	—	—
1894	3	1	2	0
1895	3	1	—	—
1896	3	2	1	0
1897	5	3	—	—
1898	6	1	2	1
1899	3	2	—	—
1900	4	2	—	—
1901	2	1	1	1
1902	4	3	2	0
1903	7	6	—	—
	42	22	8	2

Recoveries.

Gastric ulcer	52 per cent.
Duodenal ulcer	25 per cent.

Age and Sex.

Perforated Gastric Ulcer.

Males	9 cases.	Average age, 37·3
Females	33 „	„ „ 26·4

Perforated Duodenal Ulcer.

Males	6 cases.	Average age, 34·6
Females	2 „	„ „ 24·5

Table II.—*Previous History of Cases.*

No gastric symptoms	5
Definite gastric symptoms without hæmatemesis	26
Hæmatemesis	8
Former dyspepsia	6
Not known	5

Symptoms immediately preceding Perforation.

No special symptoms	40
Hæmatemesis	2
Under treatment in hospital	2
„ „ as out-patient	1
Increasing pain and vomiting	5

Table III.—*Incidence of Complications.*

	Non-fatal cases.	Fatal cases.
Parotitis	4	1
Pleurisy, plastic or serous	6	9
Empyema	—	2
Pneumonia	1	2
Pulmonary abscess	—	1
Thrombosis	3	—
Hæmatemesis	1	2
Hæmorrhage from another ulcer	—	1
Nephritis	1	—

TABLE IV.—*After Condition of Successful Cases.*

No gastric or other symptoms	11
Œdema of leg following thrombosis	1
Symptoms due to peritoneal adhesions	1
Dyspepsia (no symptoms of gastric ulcer)	4
Not traced	7
	24

DISCUSSION.

Mr. G. R. TURNER stated that seven of the cases referred to in the paper had been under his own care. In regard to drainage, he had used it in all the seven cases, draining the kidney regions, the pouch of Douglas, and in all cases the upper abdomen. He held that it was essential in some cases, and of benefit in nearly all. In one case in which soiling of the peritoneum was slight it was for a time thought to be unnecessary, but a hypogastric incision revealed a large amount of stomach contents in the pouch of Douglas.

Of seven cases two had died: in one the condition was practically hopeless from the time of admission, so that he was doubtful whether an operation should be performed; in the other the perforation was a large one, and there was acute general peritonitis. In two out of the five that recovered (who were all females) there was thrombosis in the left leg. Why thrombosis should occur so often on the left side was not clear, but Sir F. Treves has shown it was not uncommon in appendicitis, a right-sided affection.

Having found the ulcer which had perforated, he always stitched it up carefully and rapidly in order to prevent further extravasation, and only then did he invaginate it and put in Lembert's sutures. The opening of the abdomen in the hypogastric region—primarily meant for drainage—facilitated irrigation. He had in one instance opened the abdomen on a wrong diagnosis, finding nothing abnormal; this was a case of pure neurosis of the imitative variety. A condition which he had found simulated the symptoms of perforated gastric ulcer was ruptured œsophagus. The pain, however, was greater, and not in the same situation.

Mr. J. WARRINGTON HAWARD emphasised the point that the consecutive series of cases in the paper was especially instructive, as they were unselected, and represented the unsuccessful as well as the successful cases. The symptoms of perforation of a gastric ulcer were often abrupt, and came on after food, but not often after exertion; but in the chronic cases where adhesions had formed exertion was often followed by leakage through a perforation. The situation of the pain after perforation gave no indication of the position of the ulcer, but before perforation the distribution of the pain and of the superficial tenderness had some localising value. The character of the pulse was an important guide; if it were steadily going up the indication for operation was strong. Pleurisy occurred in one half of the fatal cases in the paper, and in many of the successful cases. This he thought was due to the direct passage of irritative

material through the lymphatics of the diaphragm; hence care should be exercised in cleansing the under surface of the diaphragm, by sponging in preference to irrigation. The necessity for drainage will depend on the amount of the escape of stomach contents and the duration of the case since perforation.

Dr. JOHN BROADBENT referred to two cases of traumatic rupture of the duodenum, which had come to necropsy. The first was that of a little girl who fell across a chair. No immediate symptoms were produced. Shortly after this she took a glass of milk and had severe pain in the abdomen, with obvious symptoms of perforation. The child died, and it was found that there was a rupture of the third part of the duodenum. The second case was that of a man across whose abdomen a ladder fell. There were no immediate symptoms, but on the following day the patient complained of pain in the loin and kidney in the right iliac fossa. The abdomen was opened in this region, but no perforation could be found. A week later he suddenly had signs of acute peritonitis and died. It was found that the duodenum had been ruptured posteriorly, and that an abscess had formed behind the kidney. The abscess had ruptured eventually into the peritoneal cavity and given rise to the acute symptoms. He thought that duodenal ulcers usually occurred in men in good health addicted to alcohol, and that rupture might be without immediate characteristic signs of perforation. The "latent period" after initial symptoms of severe pain and vomiting, with some degree of collapse, might be protracted, and a subphrenic abscess was a not uncommon sequela. The symptoms were, he thought, less severe than in gastric ulcer, and the perforation was apt to give rise to symptoms of an indefinite nature, as the duodenum, being usually empty except after a meal, the escape of contents was small, and adhesions might form and give rise to a localised abscess. Many cases had been operated on for appendicitis, and the perforation in the duodenum had not been detected.

Dr. H. S. FRENCH asked what the pathology of the parotitis was; if antiseptic mouth washes tended to prevent it, and if it had any relation to carious teeth. He alluded to the differential diagnosis of perforated gastric ulcer from the gastric crises of tabes; also to similar signs from rupture of the tunica intima of the aorta and thrombosis of the inferior vena cava. He asked if the results were always so favourable as those recorded in the paper as to the after condition, and he mentioned the case of a man whose life is a burden to him from the severe pains which he has had continuously after an operation for perforated gastric ulcer performed nearly two years ago.

Mr. C. B. KEETLEY stated that his experience coincided, in the main, with the statistics in the paper. Before 1899 he had not had an opportunity of operating on any case which was not either already moribund from septic peritonitis of several days'

duration, or else developed into a subphrenic, or pleural, or even pulmonary abscess. Since then he had had twelve, and had operated on nine. Of these six recovered, and three died; the three not operated all died. The fatal cases were late cases, the operation being three or four days after the perforation; the others were recent, being operated on within thirty hours. In one of the three fatal cases a second perforation complicated the after progress of the first operation. In another, severe hæmorrhage occurred, and the patient died in a few hours. Gastro-enterostomy might be of much value in some cases. Many patients did afterwards suffer from gastric trouble; half his own so suffered, and in one of these, gastro-enterostomy was required, and in another separation of adhesions. Both of these patients were cured by the operation. The question of gastro-enterostomy should not be dismissed too summarily. A gastro-enterostomy protected against a second perforation and against hæmorrhage.

Dr. G. Newton Pitt said that from his own experience he was in favour of mopping out the abdomen as against irrigation, except when extravasation was very extensive. Another point was whether the material that escaped was very virulent or not, because general poisoning occurred from the passage of the fluid through the lymphatics in the diaphragm. The latent period, with abeyance of symptoms, probably partly depended on the quiescent condition of the diaphragm. When the diaphragm moved vigorously, toxæmia would develop more rapidly, and the pulse would become rapid. In doubtful cases of perforation a leucocyte count and an estimation of the specific gravity of the blood are of great value, and might decide the question as to whether operation was indicated. Do any cases of perforation occur without rigidity of the abdomen?

Dr. Vere Pearson referred to the question of liver dulness. Some diminution occurred very frequently without perforation, in one third of 160 cases. In young females with long chests and small livers the liver would not extend to the costal margin, but this was not all. Neither could it be due to distension of the colon or dilated stomach. It was conceivable that owing to pain there might be stagnation of colon contents, and some hypertonus leading to its distension. This diminution of liver dulness was commoner in females and in younger subjects, and there was not much food in the stomach in the cases he had seen. It occurred in gastritis, dysmenorrhœa, influenza with abdominal symptoms, biliary colic, etc.

Mr. H. J. Paterson also opposed the irrigation of the peritoneum, and thought even mopping might often well be dispensed with; both were a source of shock, and simple drainage seemed to give better eventual results. The parotitis appeared to be due to septic absorption from the mouth, brought about by its dry condition, and might be obviated by antiseptic mouth

washes and lubricants. The question of gastro-enterostomy was of importance; it certainly increased the length of the operation, but not much; the risk was not, he thought, increased. He also had a fatal case from late hæmorrhage which might have been saved by this measure. It was, indeed, a question whether it should not be performed as a routine operation if the patient's condition would allow it. The advantages were the giving of physiological rest to the stomach, the facilitating of the healing of other ulcers if any were present, making further perforation unlikely, and preventing hæmatemesis. It also made it possible to feed the patient much more early—indeed, at once.

Mr. CLINTON T. DENT said in regard to the question of drainage, he had come to the conclusion that it was better to dispense with it. Occasionally drainage was advisable, but in most cases it was unnecessary. With regard to irrigation and mopping out the peritoneum, he had learnt to adopt the same general line of practice. Gastro-enterostomy was by no means an unqualified advantage, and was not devoid of risk; and if unnecessary, as it was in most of his cases, that was a sufficient argument against the extra operation. In any case, after operation for perforation, whether gastro-enterostomy were performed or not, early feeding should be had recourse to. Patients in whom a perforated gastric ulcer had been sewn up might be safely given food by the mouth twelve hours after operation, and it seemed to him quite erroneous to imagine that the performance of gastro-enterostomy enabled the patients to be fed earlier.

Mr. CRISP ENGLISH, in reply, did not think the parotitis was septic, because suppuration was so rare. In three quarters of all the cases he had seen reported in medical literature there had been no subsequent gastric symptoms. In two of the cases where nothing was found the abdomen was rigid, and the pulse was 120: the blood was not examined. He reverted to the question of gastro-enterostomy: the mortality of the operation for any cause was, at the lowest possible estimate, 5 per cent., and it probably involved an additional 10 per cent. mortality in these cases of perforated gastric ulcer, as the subjects were unfavourable; there was very little risk in feeding the patient after four or five hours, without gastro-enterostomy having been done, as firm adhesions formed so rapidly.

THE ANÆMIAS OF INFANCY

BY

CLIVE RIVIERE, M.D.

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In the first two years of life anæmia of a slight grade not infrequently shows itself, mostly in association with rickets; but every now and then cases of more advanced anæmia present themselves, and, on account of certain peculiarities with which these cases are associated, they have had a separate label assigned to them, and generally go by the name of "anæmia splenica infantum." Whether such cases belong to a class by themselves, and whether they have any claim to be considered a specific blood disease, we will discuss later on. Let us first review them as they stand.

I have tabulated the blood conditions found in the thirteen cases which have come under my notice, but space does not permit me to describe their symptoms in detail; I can only give a short *résumé* of those features which they presented in common.

The clinical picture they exhibit is closely similar in all the individual cases.

A child, most often between the ages of nine and eighteen months, is brought for advice because it has been gradually losing colour and flesh, and has become listless and apathetic. Occasionally the enlarged abdomen, or even the splenic tumour, is the first thing noticed. The

onset has been insidious, there is always a history of digestive disturbance of some grade, and the child is nearly always hand-fed, generally injudiciously so.

On examination the child shows considerable anæmia, with a lemon-yellow, waxy skin; it is poorly nourished, and its muscles are exceedingly flabby and toneless. There is nearly always rickets, and that generally of a marked grade. The heart is somewhat dilated, and there is often a soft systolic murmur at the apex or a hæmic murmur at the base. The abdomen is protuberant and tympanitic; the spleen is enlarged and firm, at times reaching nearly to the crista ilii; I have never felt a friction-rub over it. The liver is large and rather firm, generally reaching one or two fingers' breadth below the costal margin. During the course of the illness the temperature shows irregular fluctuations, raised at night and normal or subnormal in the morning, though periods of apyrexia may intervene. The bowels are opened many times, sometimes seven or eight, in the twenty-four hours; the stools are often greenish and offensive; occasional vomiting is not uncommon.

A hæmorrhagic condition in my experience is not common, even in fatal cases, only one of my own cases showing such, and that to a slight degree.

The condition recovers if slight, or if more severe improves under careful treatment, but tends to relapse, and the child often lingers a considerable time till a complication, either broncho-pneumonia or one of the infective fevers, leads to a fatal issue.

This represents an outline of the condition, but within this several interesting points occur, and must be separately dealt with.

Firstly, the condition is distinctly more common among Jewish than other children; perhaps I should qualify this and say Polish Jews, as most of my cases, and, indeed, most of the East End Jews, belong to this nationality. For this reason the disease is the more difficult to study, as post-mortem examinations are rarely to be obtained,

and the mothers are often with difficulty persuaded to leave their children for hospital in-patient treatment.

It has been noted by some observers that twins are not infrequently affected; among my own cases neither twins nor, indeed, multiple cases in one family have occurred.

With regard to the grade of rickets present, this has generally been very marked, and more especially has the cranial bossing been out of all proportion to any I have seen elsewhere, and was present in marked degree in half my cases. This has been before remarked upon by Dr. J. S. Fowler (1) in a paper read before the British Medical Association in 1900. In some of my cases there was also associated with this bossing some craniotabes in the occipital region, and these two conditions occurred apart from any syphilitic taint. In only one of my cases was congenital syphilis present.

Enlarged glands are described by many observers; in only two of my cases were they present, and they appeared to exert no influence upon the proportion of lymphocytes in the blood, nor on the course of the disease. The disease is found in both sexes; in my own cases females preponderated in the ratio of 2 to 1, but it does not seem probable that this is more than an accidental difference.

Jaundice may occur during the course of the illness; Fowler (1) records three instances among his cases. In one of my cases it was described in the history. I have since seen it in a case not included in my series; in this case it was obstructive in character, and probably represents an accidental complication due to the gastro-enteric catarrh. When we speak of the gastro-enteric catarrh it brings us close, I think, to the etiology of the diseased condition in most of the cases; we will therefore postpone its consideration for the present.

The Blood.

The results of the blood examinations made on my cases are shown in the accompanying table. The counts were

done with a Thoma-Zeiss apparatus, the hæmoglobin estimated with von Fleischl's instrument, and the differential counts were made from films stained with Ehrlich's triacid stain after fixing with heat.

Red Cells.—The red cells varied from 1,870,000 to 3,720,000 per c.mm. on first examination, the majority being just under 3,000,000. From this they rose to normal under observation in a few cases. The colour index was always below the normal, which is about 0·8 in infancy; a common figure was 0·5 or 0·6. When improvement took place the red count and the hæmoglobin generally rose together, leaving the colour index unaltered. The red cells showed much variation in size, very many cells smaller than normal, and a few larger being present. Less alteration in shape was observable. Polychromatophilic changes could generally be seen even with the triacid stain. Nucleated red cells formed a striking feature, and were present in all cases; they did not appear to bear any relation to the proportion of red cells present. The number falls noticeably as a case improves. Of these nucleated red cells a large proportion, from 20 to 40 or 50 per cent., were megaloblasts. A few microblasts were also present. The proportion of megaloblasts seemed to bear no relation to the severity of the case, nor does this proportion sensibly decrease or alter when improvement takes place. Their numbers are then reduced in the same ratio as the normoblasts.

Leucocytes.—The number of leucocytes varied between 5000 and 38,000 per c.mm. in my cases. All numbers between these two extremes were represented except that they were mostly above the normal 10—12,000 per c.mm. of healthy children.

The differential count in these cases presents considerable difficulty. Firstly, among the non-granular cells it is very difficult to make any useful division into large and small, as should be done, of course, if we accept Ehrlich's conclusions as to their quite different origin. As a matter of fact, in this condition there is every grade between the smallest and the largest, the difficulty being caused by

the occurrence of large forms of lymphocyte difficult to separate from the normal large hyaline cell. For this reason, I fear the division attempted in my table between them is purely arbitrary, and it would perhaps lead to less error had they been grouped together.

Another difficulty in some cases is in deciding between small myelocytes and polymorphonuclears, as transitional forms often appear which quite baffle classification. This probably accounts for the rather various myelocyte counts of different observers.

The leucocytosis in these cases affects as much the lymphocytes as the polymorphonuclear cells, so that with an increase in absolute numbers they keep their relative proportions or thereabouts. It must be remembered that in infancy the proportion of lymphocytes is greatly in excess of that in adult life, and they normally represent at least 50 per cent. of the leucocytes present. This may be due to the greater activity of lymphatic structures in infancy and early childhood.

The eosinophiles increase or remain normal in this diseased condition as a rule, so that the proportion to the other cells is little changed. Mast cells are found, but the detection of these with the triacid stain is so unsatisfactory that I do not claim much accuracy for the percentages given to them in my table.

Besides these normal cells, in which a general increase occurs, an abnormal visitor, the myelocyte, appears in proportions varying from 1 or 2 to 20 per cent., 4 or 5 per cent. being a common find. Occasionally these cells are found bearing large granules, eosinophilous myelocytes, and in one of my cases as many as 5·3 per cent. of these appeared in the blood on one occasion.

And now, are we or are we not dealing with a specific blood disease? The best answer to this is another question. Is there any other form of marked anæmia recognisable in infancy? The answer I should make to that is—No! I have never seen it, have never found a description of such, and see no reason at present to believe

in its existence. If cases of marked anæmia of quite other type do exist in the first two years of life, they are very rare, and must represent some specific blood change, for the common anæmia of infancy is that which progresses, when severe, to the picture of a so-called "anæmia splenica infantum."

May I here remark that the age of two years, which I have fixed as the limit of infancy, is, so far as anæmia is concerned, no arbitrary point of time, as might at first sight appear, for above this age the infantile anæmias rapidly disappear and examples of the adult anæmias begin to be recorded.

The marked anæmias of obvious causation, such as congenital syphilis, show all the changes claimed by some as peculiar to anæmia splenica infantum. I have at the present time under observation an infant of four months suffering with congenital syphilis of unusually severe type. It presents to observation an interesting double picture: its "obverse" shows a typical severe syphilis with baldness, *café-au-lait* skin, rash, and snuffles, etc.; its "reverse" depicts an anæmia splenica infantum. The spleen and liver are enlarged, as we should expect; blood examination shows 1,590,000 red cells per c.mm. with 30 per cent. hæmoglobin, and 10,000 whites per c.mm., whose differential count is as follows:—

Polymorphonuclears	30·4	per cent.
Small mononuclears	35·0	,,
Large mononuclears	11·0	,,
Eosinophiles	5·0	,,
Myelocytes	17·0	,,
Eosinoph. myelocytes	1·6	,,

There are 3·2 nucleated reds to every 100 white cells, and of these more than a third are megaloblasts.

Johann Loos (2) examined sixteen cases of anæmia due to congenital syphilis with a similar result: all showed the blood changes characteristic of the so-called "anæmia splenica infantum;" and Luzet (3) describes similar changes in cases of anæmia following epidemic diarrhœa.

I would opine, then, that anæmia in infants, when sufficiently severe, always presents the peculiarities seen in these cases—the peculiar appearances noted in the blood, and enlargement of spleen and liver ; or, to transpose it, that " anæmia splenica infantum " spells merely severe anæmia occurring in infancy, its peculiar characteristics being due to the " infancy " factor rather than the " causation " factor.

If this is so, we should expect to find all grades of anæmia from the slightest passing insensibly into the more pronounced condition; and this I hold that we may do—every grade in the anæmia, every grade in the splenic enlargement, and every grade in the blood peculiarities from one myelocyte and one erythroblast in a differential count up to the large percentage of both found in the more advanced cases. The blood changes depend on the age of the child, not on any peculiar reaction to a specific causation. It must be admitted that, though every grade may be found, it is not so easy in practice to produce cases in intermediate stages, for this reason—either the anæmia clears up rapidly, or it rapidly reaches an advanced stage, and once there a vicious circle, presently to be described, is set up, and the patient remains for months in the condition described as " anæmia splenica infantum."

It is difficult to say at what stage the nucleated red cells, myelocytes, etc., appear in the blood, though I believe the anæmia must be fairly advanced before this occurs. Cases occasionally appear in which fairly marked anæmia is found without these blood peculiarities, and such cases may be brought forward by some, and contrasted with certain cases of " anæmia splenica infantum," in which the anæmia is only slight, but the blood contains nucleated reds and myelocytes, to prove the specific character of these changes. I think the real explanation is that these first cases have not yet reached the stage at which the blood peculiarities begin, and the cases with which they contrast them are anæmias which have been severe, but are then recovering, the peculiar

blood appearances remaining long after the anæmia has reached a quite mild grade.

And now, having denounced the specific causation of the condition, we are left to grapple with its etiology. I have already claimed indirectly that many causes may produce its peculiarities, being merely those of severe anæmia in infancy, and it seems probable that the proportions of those various factors which go to make up these peculiarities vary somewhat according to the causation at work. Indeed, it may be possible at some future time to determine this causation by slight variations in the symptoms present. I have mentioned syphilis as a cause, but this, though occasionally present, is certainly not accountable for the bulk of the cases.

I have already alluded to the gastro-enteric catarrh accompanying and preceding these cases, and this is, in my opinion, the prime cause of severe anæmia in infancy, and this cause can generally be traced back one step further—namely, to injudicious feeding. Of course the diarrhœa and vomiting will, by those who regard the disease as a specific anæmia, be considered only as part of the disease, or as common complications thereof. I admit that, once established, the anæmia, being a great causative factor of intestinal catarrh, tends to keep this going. Each reacts upon the other, and this is that "vicious circle" to which I have alluded above; but I hold that in most cases some catarrh can be shown to exist before the anæmia commences. Once this vicious circle is established, it is difficult to prevent the downward progress of the case, and it is this, I think, which tends to make rather a sharp line of demarcation between these cases of severe anæmia and the slighter grades in infancy; once a certain point is reached recovery is very difficult, and they remain a long while *in statu quo*, the ready prey to those complications which so often hurry on the fatal issue; on the other hand, if this point is not reached they tend to recover rapidly, and so the stages between are not largely represented clinically.

Among my own cases gastro-intestinal disorders formed an almost constant factor, and they generally preceded the disease by a considerable interval. Only one of my cases had been breast-fed throughout; the others had been so fed generally for the first few months, just long enough to bridge over the time at which "marasmus" so commonly occurs. Occasionally they had not been breast-fed at all. In all cases the subsequent feeding had been of a most undesirable nature. Among the Polish Jews, from whom more than half my cases come, breast-feeding is the rule; and when this fails, as, fortunately for them, it seldom does, they have even less idea of hand-feeding than English mothers in the same class of life. This is sufficient, I think, to account for the excessive proportion of Polish Jews among my cases, but to it may be added the fact that slight grades of anæmia also are very common among these children, and seem very readily produced.

In the first few months of life gastro-intestinal catarrh leads to marked wasting, but in the later months of the first year, when the disease under consideration tends to appear, marked wasting less commonly shows itself than does rickets with poor nutrition and flabby muscles, so that these anæmias may be taken to correspond in later months to the marasmus of early infancy. In the early months the injured intestinal glands are unable to take up nourishment, and the child starves; in the later months they have learned their function in this respect, and take up not only nourishment, but in addition toxins formed from the altered food substances.

That rickets can be a cause of anæmia, or, indeed, of anything other than mechanical deformities, I cannot persuade myself to believe, being itself but a series of symptoms—a reaction of certain tissues to some cause or causes underlying it. That one of these causes—namely, gastro-enteric catarrh—may, at the same time that it causes rickets, also lead to marked anæmia, and that an anæmia of such a kind as has been described under the title

"anæmia splenica infantum," I believe and hold. The rickets, in my opinion, in these cases runs parallel to the anæmia. That the anæmia may occur without rickets, and that rickets is not necessarily associated with marked anæmia, proves that neither depends on the other, nor can their causation be altogether identical.

And now, how does the intestinal catarrh act as a systemic poison? Intestinal toxins have been conjured up to explain so many varying conditions, and their appearance is so trite and convenient as a causative agent that it is with some shame and with many apologies that I drag them forward. If I could give you a table of their analysis, if I could exhibit them on a plate, it would be very gratifying to me and very edifying to the Fellows of this Society; but, although this may not be done, yet we cannot afford to ignore their formation. In cases of acute gastro-enteritis in infants, no one would have the hardihood to deny an absorption of toxins from the intestinal canal; when such a condition of toxin formation and absorption goes on insidiously over a long period of time a different train of symptoms will be produced, a slow poisoning of the tissues, leading—why not?—to marked rickets and severe anæmia, the so-called "anæmia splenica infantum." The organisms causing acute summer diarrhœa have yet to be definitely decided upon. Shiga's bacillus (4) and various members of the Coli group have been claimed as such, and it seems probable that more than one organism, given favourable conditions, is capable of causing the symptoms of this disease. Similarly, in chronic catarrh, set up in the first place by unsuitable food, it is probable that the growth of micro-organisms, differing perhaps according to the food supplied, may serve to keep it going, and that the products formed by their growth in these food substances, being absorbed, will cause a progressive poisoning of the human host. Once a suitable culture medium is prepared for them in the intestine, there is no lack of organisms, either already present or introduced in food through the disordered stomach, to

flourish upon it. Another possible source of poisoning remains to be mentioned—namely, toxins formed as the by-products of disordered digestion in these cases.

And now, though we may not believe that we are dealing in anæmia splenica infantum with a primary blood disease, though we hold that those peculiar cells the occurrence of which is described above are readily called forth into the blood in infancy, still there must be a *modus operandi* under which they appear; they are not there without cause, and since we believe that an intestinal toxæmia is that commonly at work, it is interesting to attempt on those grounds some explanation of the changes observed. The views of Ehrlich as to the origin and destination of the blood cells seem to be those most widely accepted. It will therefore be convenient to base a working hypothesis on those views.

We have supposed a toxin formed in the intestinal tract either by the action of micro-organisms on the undigested food-stuffs or as a by-product of disordered digestion. This, by its local action, will cause diarrhœa and vomiting, and, by the stimulation of intestinal lymphoid tissue, will wash into the blood that increase of lymphocytes which commonly accompanies a gastro-intestinal catarrh in children. The poison circulating in the blood stimulates the bone-marrow; by an active chemiotactic reaction an increased supply of polymorphonuclears and eosinophiles takes place, causing a leucocytosis, perhaps with a view to helping in the formation of antibodies to the poisons in the blood; but after a time this leucocytosis fails relatively, and to keep up the demand only partially formed granular cells, the myelocytes, antecedents of the polymorphonuclears, appear in the blood. If this failure of leucocytosis is a fact, it should not be possible to cause a polymorphonuclear leucocytosis in one of these cases. I am not sure about this point. One of my own cases during an attack of pneumonia showed an increase of leucocytes generally, though no relative increase (even a slight decrease) of polymorphonuclears.

The leucocytosis having failed to overcome the poison, and the same being still formed, a destruction of red cells takes place, the spleen being enlarged partly to dispose of the refuse of these and the dying leucocytes.

That an increased destruction takes place seems to be supported by the following facts:—(1) The presence of erythroblasts in the blood, suggesting an attempt on the part of the marrow to keep up the supply. The megaloblasts present probably depend merely on the age of the patient, these being normally present in the marrow of infants. (2) The altered proportions between the young cells (large mononuclears and myelocytes) and the old cells (the polymorphonuclears) seem to point to increased destruction of the latter. (3) The alterations in size and shape of the erythrocytes may be due to a degeneration preceding their death.

It might be argued, on the other hand, that these changes may be brought about by a poisoning of the blood-forming organs resulting in their inability to supply adult cells to the blood, and so allowing immature forms to enter the circulation.

If the increased destruction were great it might cause some increase in the iron content of the organs, especially of the liver if it occurred in the portal circulation, as one might expect in an intestinal toxæmia. If the destruction were in the general circulation, on the other hand, there might be no demonstrable increase of iron content in the abdominal viscera.

In the only fatal case I have had in which an autopsy was permitted, I got Dr. W. H. Hurtley to estimate the iron in liver, spleen, and kidneys. He employed two methods for comparison, and found in the spleen 0·01585 per cent., or 0·01818 per cent.; in the liver 0·01527 per cent., or 0·01566 per cent.; in the kidneys 0·022 per cent., or 0·00287 per cent., or 0·0036 per cent. of iron as the result of three experiments with the two different methods.

Dr. William Hunter (5), among twenty collected analyses of normal organs, found the iron content for the adult an

average of 0·078 per cent. for liver and 0·171 per cent. for spleen. The percentages in the normal child seem to correspond closely with these among the few analyses in infants I have been able to find.

We see, therefore, that the percentages in my case of anæmia were low, and, even allowing for an increased bulk of liver and spleen, do not point to any excess of iron in these organs such as occurs in the liver in pernicious anæmia. Does this mean that blood destruction plays no important part in this disease? I think not!

Let us glance at the condition in pernicious anæmia. In that disease Dr. William Hunter has clearly shown that the blood destruction occurs in the portal circulation, and the poison, intestinal in origin, as also the products of its action, the iron etc., never get beyond this point, but are dealt with by the liver before they reach the general circulation. But we have advanced the theory of an intestinal toxæmia in these anæmias of infancy also; how does it differ from that described above? Obviously in this, that in them the poison reaches the general circulation! The myelocytes and increased polymorphonuclears clearly point to a direct action through the blood-stream on the bone-marrow. We must thus suppose that the toxin, though entering the portal circulation as in the case of pernicious anæmia, is not destroyed by the liver, but finds it way into the blood-stream wholly or in part, and there exerts its action on systemic structures. The blood destruction, if such exists, occurs in the general blood-stream, and its products are scattered broadcast instead of being seized and stored in the liver, as in pernicious anæmia. On the other hand, it seems quite likely that a deficient formation as well as a blood destruction is at work in this condition. That the blood-forming organs, and especially the bone-marrow, are disturbed in this affection, we have evidence in the unusual distribution of the leucocytes; and the relative deficiency of the hæmoglobin content of the red cells seems to point to the same, and suggests a likeness to chlorosis in which a deficient production in all

probability takes place, whether a dilution of the plasma is also present or not.

Three severe blood conditions in infancy have received recognition at various times in the past—anæmia splenica infantum, anæmia splenica pseudoleukæmica of von Jaksch, and leukæmia. The first we have considered; when we come to a consideration of the other two we are met at the outset by a great difficulty—namely, the very imperfect blood examination made on the cases described.

Let us take leukæmia first; and by this term I mean spleno-myelogenic leukæmia, for it is this variety that the infantile anæmias resemble.

What grounds are there for believing that spleno-myelogenic leukæmia occurs in infancy? It may be remarked at once that the grounds are narrow, but they are grounds it would be difficult to ignore. A fair number of cases have been described, but many on quite insufficient evidence; and apart from one or two cases, in which the matter was more thoroughly proved by post-mortem examination, one might be inclined to discredit the occurrence of the disease at all in the first two years of life.

The most complete case I can find is one described by von Jaksch (6) in 1889. In this case, that of an infant 14 months old, there was a progressive increase of leucocytes up to 192,000 per c.mm. at the time of death. At the autopsy the organs showed typical leukæmic changes, and these were confirmed by microscopic examination. No differential count was made. Then comes a case of Stilling's (7), an infant of 12 months, in which the organs showed definite leukæmic changes on the post-mortem table. No blood examination was made. A third case is that of Hochsinger and Schiff (8), aged 8 months; it developed tumours of the skin, which microscopically showed a typical leukæmic infiltration. It appeared to be a mixed splenic and lymphatic leukæmia, but no post-mortem examination was obtained. Middleton's (9) case, an infant of 16 months, showed a leucocyte count of 370,000

per c.mm. (no differential count being made); but post mortem no naked-eye leukæmic changes in the organs were found, though microscopically the capillaries were found stuffed with leucocytes, representing, perhaps, an early leukæmic infiltration. Drs. Rolleston and Latham (10) have described the autopsy on a child of 18 months, whose organs showed a similar change; but they seemed loth to consider it a case of leukæmia, and on other grounds a diagnosis of lymphadenoma was made. In all the other cases I have been able to trace, there has been some omission which has weakened their claim to be considered instances of this disease. In Morse's (11) case, so often quoted, no post-mortem examination was made, and there is, to my mind, nothing about the blood condition which clearly separates it from other cases of grave anæmia in infants. The myelocytes, it is true, rose to 21·4 per cent., but one of my own cases showed a myelocyte count of 21·5 per cent. and a larger eosinophile count than his. Perhaps I ought to have called this a case of leukæmia, but I could see no clear reason for doing so in the absence of a post-mortem examination. Another of my cases which has improved considerably under treatment showed 16 per cent. of myelocytes.

These represent all the cases I can find in infants under two years in which a claim for leukæmia was made. In children of three or four years, an age somewhat beyond the limits of those anæmias with which this paper deals, a few cases also of leukæmia, both spleno-myelogenic and lymphatic, have been described.

I think, then, we must allow that though rare and somewhat atypical, as we shall see hereafter, cases which must be called leukæmia do occur in infants.

In the year 1890 von Jaksch (12) described some cases which he burdened with the somewhat cumbersome title of "anæmia infantum pseudoleukæmica," and these he separated from leukæmia on the one hand and from splenic anæmia of infants on the other. They were cases in which a leucocytosis occurred out of proportion, he

thought, to cases of so-called "splenic anæmia," but in which the post-mortem lesions of leukæmia were missing.

To recapitulate shortly the changes found in our "splenic anæmia" cases—we have considerable anæmia, enlargement of spleen and liver, and, generally, advanced rickets. The blood shows a low red count with a still lower colour index. The leucocytes are moderately increased, and a differential count among them shows myelocytes in fair numbers and many nucleated reds, both normoblasts and megaloblasts. The cells normally present keep near the normal proportions of infancy.

Now how do these cases differ from those described by von Jaksch as "anæmia splenica pseudoleukæmica?" Von Jaksch himself sums up the difference on three lines:

(1) The smaller leucocyte count.

(2) The absence of progressive increase of leucocytes.

(3) The presence of marked rickets.

The leucocyte counts in his three cases at their highest were respectively 54,000, 114,000, and 36,000 per c.mm. The latter two of these cases recovered, and the count fell in one case from 114,000 to 10,000 per c.mm. in three weeks, and in the other case from 36,000 to 12,500 per c.mm. in six weeks. In face of this fall, and of the way in which the interval between the high and low counts is bridged over by intermediate cases, surely the large leucocyte count cannot be seriously quoted as a distinction between these cases and the splenic anæmia cases described above. If any here think that it can, I should be very glad to learn at what number of leucocytes per c.mm. they would place the line of demarcation between them.

As for the progressive increase of leucocytes, this may occur in fatal cases of all sorts, and is not peculiar to von Jaksch's cases. Death depends upon persistence of the morbid condition, except when due to complications, and the leucocytosis runs parallel with this.

With regard to rickets, no very definite conclusion can be drawn. All my cases, except one, had rickets, most of

them marked rickets; and I am disposed to regard the condition as a result of the same cause that produces the anæmia rather than as itself contributory in any way to the causation of the disease. The case in which there was no rickets differed in no respect from the other cases, either in history or symptoms; moreover in one of von Jaksch's 3 cases bad rickets is mentioned, so that this disease, since it is not always present in the one condition, and may be present in marked form in the other, can be taken neither to explain the one nor its absence to distinguish the other. Morse affirms the presence of rickets also in nearly all authentic cases of leukæmia, which has some bearing on what follows.

It may be accepted then, I think, that the difference between the cases described by von Jaksch as "anæmia splenica pseudoleukæmica" and the cases of anæmia with enlarged spleen described above is one of degree only and not of kind.

And now the question arises: In what respect, if at all, do these cases of anæmia splenica differ from those of leukæmia mentioned above?

Firstly, we do not find that the blood condition in these cases of leukæmia quite corresponds with what we should expect to find if we reason from the grounds of the same disease in the adult. In the adult we have an average of about 300,000 white cells per c.mm., and of these about 30 per cent. are myelocytes; moreover there is a definite increase of eosinophiles and mast cells. Now in healthy infants the leucocyte count is somewhat higher than in adult life, and a leucocytosis is, admittedly, very readily set up; and yet in these cases of leukæmia what do we find? Only 192,000 per c.mm. in von Jaksch's case at the highest, and only 48,000 in Morse's case; whereas in older children, quoted by Cassel and Baginsky at eight and nine years respectively, there is no such failure in this respect, the leucocytes being 500,000 and 986,000 per c.mm. respectively. This alone, in the absence of a post-mortem examination, throws considerable doubt on Morse's case;

and the very moderate myelocyte count of 21·4 per cent. among these seems to confirm it. In Middleton's case, on the other hand, there were 370,000 leucocytes per c.mm., a much more respectable number. In the other cases, unfortunately, the leucocytes were not counted—merely recorded as increased. More unfortunately still, we miss the advantage of a differential count in all but Morse's doubtful case; for, seeing the readiness with which myelocytes appear in the blood of infants (in diphtheria, etc.), and also the ease with which an eosinophilia is in them set up, we should expect to see a very striking percentage of these two classes of cell in leukæmia. In Morse's case, as we have seen, there are only 21·4 per cent. myelocytes, a number which may be reached in fatal cases of anæmia splenica infantum, and only 0·6 per cent. of eosinophiles, which represents no definite increase at all in such a comparatively small leucocyte count. In Rolleston's doubtful case the myelocytes numbered 20 per cent. and the eosinophiles 1·6 per cent.; but we do not know what absolute increase this represents, as no blood count was made. In neither Middleton's nor von Jaksch's cases was a differential count made, but the latter informs us that there was no increase of eosinophiles.

So that in those cases recognised as leukæmia, in which a blood examination was made, we find that the blood does not bear the characters we should have expected under the modifying influence of infancy.

Once more, where do these cases of leukæmia differ from cases of splenic anæmia and von Jaksch's anæmia already described, and where does the line of demarcation come, if such exist? That their appearance is strikingly similar is illustrated by the difficulty the older observers had in separating the two conditions; indeed, many of the splenic anæmias were described under the heading of leukæmia. Von Jaksch considers that the conditions can be separated clinically on several grounds—

1. He says the liver is more enlarged in leukæmia than in splenic anæmia. What do we find on examining

the facts? In von Jaksch's own case of leukæmia the liver was only just palpable below the ribs, and after death weighed 500 grammes, with a spleen of 430 grammes; in my own fatal case of splenic anæmia, in which a post-mortem examination was obtained, the age of the child was the same; the liver weighed 405 grammes, compared to a spleen of only 112 grammes; *i. e.* in my case of splenic anæmia the liver weighed nearly as much absolutely, and, relatively to the spleen, much more than in his case of leukæmia. In Hochsinger and Schiff's case the liver was larger, reaching below the umbilicus; in Middleton's case the liver is definitely mentioned as *not* enlarged; in Stilling's case it is said to be rather large, but no weights are supplied; in Morse's case it came two fingers' breadth below the costal margin; so that the enlargement of the liver as a point of diagnostic importance between the two diseases appears to be of very little worth.

2. The second point von Jahsch states is that the eosinophiles are increased in leukæmia, but diminished or absent in anæmia splenica. This increase in leukæmia is certainly what we should expect, but we have already seen that in leukæmia infantum they seem to be *not* necessarily increased, and in von Jaksch's own case he definitely states that no increase occurred. On the other hand, there is a fair percentage (generally about 1 per cent.) working out to a slight real increase, or at any rate no diminution, in the other disease as illustrated by my own cases.

3. His third point is that anæmia is a more important feature among the cases of so-called anæmia splenica infantum than among cases of leukæmia in infants, but I do not think this distinction is of much value. One of my cases died without definite complications with a blood count of 3,750,000 red cells and 23 per cent. hæmoglobin, another with 3,180,000 reds and 30 per cent. hæmoglobin; while in von Jaksch's own case of leukæmia the red cells fell to 2,310,000 per c.mm. before death, in Middleton's case they were 3,300,000, and in Morse's supposed case

2,900,000, so that there is really nothing to be said between the grades of anæmia in the two conditions.

And now comes the only distinction which appears of importance—the only line, as far as I can perceive, which can be drawn between the two diseases, and it is this: in leukæmia the organs are found after death to be infiltrated with leucocytes; in anæmia splenica, on the other hand, they are not.

Can this barrier be passed? Can we conceive that perhaps this, too, only represents a grade of disease, that anæmia splenica infantum is merely leukæmia which has never reached the stage at which infiltration of the organs occurs, and that leukæmia merely represents an acute and advanced phase of the less serious-looking disease? I would advance the suggestion that we can! I cannot help thinking that cases will be found bridging over the gap between severe anæmia and leukæmia of infants—cases in which an infiltration of the organs is beginning to take place at the time of death—in which, though no alteration is observed in the organs by the unassisted eye, yet the microscope reveals the early beginnings of that change which in a more advanced grade causes the distinctive lesions of leukæmia. Are not Middleton's and Rolleston's cases illustrations of this commencing infiltration?

If we accept these contentions which I have laid before you, to what do we commit ourselves?

1. That *severe* anæmia in infants commonly presents the picture of so-called anæmia splenica infantum, or of anæmia splenica pseudoleukæmica, and that the causation of such severe anæmia is generally an absorption of intestinal toxins.

2. That if the condition is *more* severe, probably from a somewhat more acute poisoning, the picture of leukæmia infantum is produced, *i. e.* that leukæmia in infants is nothing more than the most advanced example of a morbid condition represented in its pre-leukæmic stages by the conditions known as anæmia splenica infantum, and anæmia splenica pseudoleukæmica of von Jaksch.

So far it looks easy; but other issues must be reconciled. Some may object that leukæmia is a very fatal disease, whereas recovery takes place from the slighter cases of anæmia splenica. This should not disturb us. Children react very differently to various diseases than do adults; and because leukæmia runs a well-recognised course, and is almost certainly fatal in later life, there is no reason why the same should obtain in infancy. The mortality, moreover, be it noted, is by no means low among marked cases of splenic anæmia (so-called). More than half of my own cases are already dead, and others are likely to follow. I can only record two recoveries as yet among my thirteen cases.

The next point we are met with is the comparative frequency of leukæmia, or rather its antecedent anæmias, in infancy, and this is what we should expect if its causation is not specific. It represents the natural reaction of the blood-forming organs in infancy to various poisons, and in this respect may be compared to broncho-pneumonia, which is also commoner in infancy than in adult life, and is the result in the infantile lung of the inroad of many different organisms.

And now we have broken the ice of the next somewhat startling conclusion to which our arguments have necessarily led us—namely, that leukæmia in infancy is not a specific disease. Something needs to be said on this head. Naturally the slighter causes of anæmia in infants would not be expected to lead on to a leukæmic condition; it is to the serious anæmias only that it is closely related. These serious cases, I would suggest, are always intestinal in origin; and, if the poisoning is severe enough, a leukæmia may be the result. Obviously there is something peculiar about this poison; it must be produced continuously over a long period of time, and it must be capable of escaping the vigilance of the liver, either directly, or by entering the blood through the lymph stream. In health the liver has the power of absorbing poisons carried to it in the portal circulation, and returning

them to the intestine in the bile. The poison of pernicious anæmia seems to be caught in this way, and exerts its influence on the blood in the portal circulation only.

On the other hand, it seems probable that many poisons are capable of evading this action of the liver, as is exemplified by cases of acute gastro-enteritis in infants. Here the symptoms of a general toxæmia are rapidly established, and it seems certain that similar symptoms may be caused by the action of more than one organism in the intestine. If this is so in cases of acute poisoning, I think we are bound to admit that in the chronic poisoning which leads to anæmia or leukæmia no specific organism need be pressed into service, but many may be capable of causing it.

This contention becomes more difficult when we turn to leukæmia in the adult. Here we see none of those slighter forms, none of those pre-leukæmic stages from which recovery may take place; it is either "neck or nothing!" This fact makes it evident that the causation in adults is considerably narrowed, that but few organisms can form poisons capable of originating the disease, and that a peculiar environment is necessary for their growth. The disease is rare!

Moreover the blood state is for the adult, though not for the infant, something quite peculiar and specific; it is no less than a return to the condition of an infantile anæmia. How can this be explained? We have dismissed the specific character of the blood changes in infantile anæmia as untenable, though we have nevertheless claimed that an intestinal toxæmia is the common cause of the condition; of the severe cases and leukæmia, probably the only cause. But if the blood changes are not specific, and depend merely on the "infancy" factor, how can these same changes be brought about at the call of a diseased condition in adult life?

For an explanation of this let us turn for illustration to another disease of infancy whose peculiarities are exhibited less frequently in adult life—namely, broncho-pneu-

monia. It must be understood that I use broncho-pneumonia as a convenient illustration only, and do not claim it as a parallel to the disease I am discussing. I am well aware that the occurrence of broncho-pneumonia in infancy depends largely on the physical peculiarities of the infantile lung, and is, therefore, not directly comparable to a tissue reaction such as that we are discussing. At the same time the illustration may be closer than at first sight appears, since the prevalence of the "leukæmic" anæmias in infancy may also depend to some extent on a physical factor—the infantile intestine in place of the infantile lung.

Acute broncho-pneumonia is essentially a disease of infancy, and can be caused by any of several organisms—pneumococcus, streptococcus, staphylococcus, diphtheria bacillus, influenza bacillus, etc. The pneumococcus, as we know, is by far the commonest cause. It is often present in the throat in health, and only awaits certain conditions favourable to its growth to set up the disease. To adults the pneumococcus is a much less formidable enemy, and, if it does gain an entry, causes, not broncho-pneumonia, as in infancy, but a somewhat different morbid condition—namely, croupous pneumonia. But broncho-pneumonia also occasionally occurs in adult life, though it is an infant's disease. The pneumococcus does not cause it, but the influenza bacillus, a very rare cause in infancy, in adult life readily sets up a typical broncho-pneumonia.

Let us apply these facts to illustrate what may occur in leukæmia. Leukæmia of adults, though it displays certain noticeable differences, bears a close resemblance in its blood changes to leukæmia and the severe anæmias of infancy, and may be considered to be, I think, a return to an infantile condition. This condition of blood is comparatively common in infancy, representing the natural reaction at this early age; and, like broncho-pneumonia, might be caused by the poisons of many different organisms (intestinal), of which probably one (like the pneumococcus in broncho-pneumonia) is more commonly active than others. After infancy is passed, the tendency to this

blood reaction is passed also; but still the condition may occasionally be set up in adult life. Like broncho-pneumonia, fewer organisms (possibly only one) may, developing in the intestine, be able to cause it in later life; and that perhaps a different one (compare adult influenzal broncho-pneumonia) to that which commonly sets it going in infancy (compare pneumococcal broncho-pneumonia). Thus, though leukæmia (including the pre-leukæmic anæmias), being only the natural reaction to various poisons, may not be considered specific in infancy, yet in adult life it may become specific in that the blood changes are quite peculiar when compared with other adult blood conditions, and its causation so narrowed down as to be practically solitary.

I would, then, sum up my conclusions as follows:

1. That anæmia from any cause in infancy, if severe enough, gives rise to the peculiar symptoms grouped under the headings "Anæmia Splenica Infantum" and "Anæmia Splenica Pseudoleukæmica" of von Jaksch.

2. That, consequently, these are not specific anæmias, but owe their peculiarities merely to the "infancy factor," and that they represent merely different degrees of the same condition.

3. That the common cause of severe anæmia in infants is gastro-intestinal catarrh, leading to the absorption of toxins either from the growth of micro-organisms, or possibly from the formation of poisonous by-products of digestion.

4. That leukæmia of infants is not a separate disease, but merely a still more advanced stage of this anæmia,—that is, that the difference between them is one of degree and not of kind.

5. That leukæmia of adults is a return to the condition of an infantile anæmia, and that, being rare, its causation is probably so narrowed down as to be practically specific.

At the conclusion I would like to express my thanks to my colleagues at the East London Hospital for Children, for their kindness in supplying me with opportunities for studying those cases which came under their care.

I feel also that an apology may be expected from me by you, gentlemen, for having placed before you so much theory to-night and so few new facts. If it is expected, I offer it in all heartiness; at the same time I cannot but feel that an attempt, however inadequate, to reason from facts already accumulated, and to build up a working hypothesis upon them, should have as much claim to your consideration as the mere accumulation of those facts themselves. If we could believe that leukæmia in infancy merely represents a severe grade of so-called splenic anæmia, and that leukæmia in adults is a return to a condition of infantile anæmia, it might, I venture to think, bring us a step nearer to the comprehension of this interesting disease.

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No. of case.	Initials.	Sex.	Age in months.	Date.	Red corpuscles.	Percentage of hæmoglobin.	Colour index.	Leucocytes.	Percentages of	
									Small mononuclears.	Large mononuclears.
				1901						
1	B. S.	F.	17	April 12th	2,680,000	38	0·7	22,000	57·5	8·0
2	R. G.	F.	14	June 8th	2,950,000	40	0·7	5,000	44·5	13·0
3	G. S.	F.	9	July 24th	2,890,000	30	0·5	27,000	45·2	16·2
				August 6th	3,180,000	30	0·4	10,000	29·5	16·0
4	F. E. (out-patient)	F.	18	August 8th	3,200,000	25	0·4	7,000	54·5	5·75
5	F. S.	F.	14	August 10th	—	—	—	—	39·6	14·6
				August 12th	2,890,000	35	0·6	37,000	—	—
				October 15th (out-patient)	5,857,000	66	0·6	27,000	54·7	8·2
6	E. A.	F.	8	November 19th (out-patient)	1,895,000	20	0·5	12,600	18·0	15·2
				1902						
			10	January 12th (in-patient)	2,630,000	30	0·6	15,000	31·2	13·6
				January 29th	3,680,000	50	0·7	14,000	43·7	10·0
				February 19th	4,140,000	65	0·8	9,000	22·2	26·0
				February 26th	4,430,000	55	0·6	12,000	35·0	33·0
				March 6th	4,820,000	60	0·6	10,000	45·7	3·5
				March 12th	4,310,000	60	0·7	14,000	44·4	23·0
				1901						
7	F. C. (out-patient)	M.	15	December 23rd	4,300,000	37	0·4	8,000	51·8	7·5
8	E. S.	F.	21	April 30th	3,580,000	25	0·4	8,000	52·7	22·0
9	J. K.	M.	14	May 1st	—	20	—	—	40·0	11·0
				May 12th	3,500,000	25	0·4	33,000	40·6	13·25
				May 21st	3,750,000	23	0·3	38,000	30·25	13·0
10	E. A.	F.	9	July 21st (out-patient)	1,870,000	15	0·4	17,000	39·0	13·3
				October 16th (out-patient)	2,260,000	?50	?1·1	15,000	40·0	20·0
				— (out-patient)	2,370,000	35	0·7	17,500	—	—
11	E. R. M.	M.	15	September 11th	3,560,000	40	0·5	?6,000	42·0	10·8
				September 18th	5,650,000	55	0·5	22,000	57·0	13·0
				September 29th	5,330,000	55	0·5	13,500	53·0	8·0
				October 29th (out-patient)	4,550,000	?60	0·6	10,000	47·0	12·6
12	J. C.	M.	13	October 24th	3,720,000	50	0·7	20,000	42·0	13·0
				1903						
				March 20th (out-patient)	4,910,000	60	0·6	12,000	—	—
				1902						
13	A. A. (out-patient)	M.	31	November 7th	—	—	—	—	42·0	5·5
				November 14th	2,260,000	30	0·7	16,000	—	—

Percentages of					Number of leucocytes counted.	Nucleated red cells per 100 leucocytes.	Percentages of varieties of nucleated reds.			
Myelocytes.	Eosinophilous myelocytes.	Polymorphonuclears.	Eosinophiles.	Basophiles.			Normoblasts.	Megaloblasts.	Microblasts.	
8·0	—	26·5	1·0	—	100	5·0	—	—	—	Died April 20th, 1901.
10·0	—	32·0	1·0	—	200	5·5	—	—	—	Discharged with varicella; ? result.
7·6	0·2	30·6	1·2	—	500	10·0	—	3·8	—	Died September 10th, 1901.
21·5	1·5	28·5	3·0	—	200	20·0	—	4·5	—	
7·0	1·0	30·25	1·5	—	400	2·0	—	—	—	Patient lost sight of.
5·0	0·4	39·4	1·0	—	500	6·0	—	2·0	—	
—	—	—	—	—	—	—	—	—	—	
3·4	—	33·3	1·29	—	500	5·8	—	—	—	
4·8	0·4	59·2	2·4	—	250	2·4	—	—	—	Died in April, three weeks after leaving hospital—? diphtheria.
11·0	0·4	42·7	1·0	0·5	550	9·0	63·0	35·0	2·0	
6·0	—	38·3	0·3	1·7	300	8·0	91·0	4·5	4·5	
4·7	—	46·6	0·7	—	320	3·7	75·0	25·0	—	
3·7	—	27·0	0·57	0·9	350	3·7	23·0	77·0	—	
0·96	—	38·7	0·4	0·8	519	0·4	50·0	50·0	—	
1·6	0·3	27·1	—	0·6	376	0·8	70·0	30·0	—	
1·5	0·3	36·7	0·9	1·2	—	? 2 extruded nuclei seen	—	—	—	Recovered.
1·0	—	23·3	0·7	0·3	300	1·3	75·0	25·0	—	
5·0	—	38·0	0·5	4·0	200	8·5	80·0	20·0	—	Died May 26th; post-mortem examination.
3·5	—	39·5	1·0	2·0	400	15·5	64·5	32·2	3·3	
7·25	—	47·25	0·7	1·5	400	9·0	60·0	35·0	5·0	
7·3	5·3	32·7	2·0	0·3	300	13·0	64·0	13·0	23·0	
3·0	0·7	34·6	1·0	0·7	300	4·0	58·0	42·0	—	
—	—	—	—	—	—	—	—	—	—	
16·4	1·0	29·0	0·4	—	250	13·2	49·0	42·0	9·0	
4·8	1·0	21·8	1·8	0·5	400	6·5	46·0	46·0	8·0	
2·8	1·6	32·5	1·25	0·6	320	6·5	47·6	38·0	14·3	
2·0	0·3	35·4	1·4	1·0	350	4·3	53·0	47·0	—	
3·0	0·3	40·0	0·3	1·0	350	23·0	63·7	23·7	12·6	
—	—	—	—	—	—	—	—	—	—	
1·0	—	50·0	—	1·5	200	1·0	100·0	—	—	
—	—	—	—	—	—	—	—	—	—	

DISCUSSION

Dr. J. H. Drysdale said that, in association with Dr. J. H. Thursfield, he had examined a large number of cases of anæmia in infancy during the last ten years, and although the facts elicited were similar to those described in the paper, his conclusions were different. He could not agree with the view that anæmia in infancy "from any cause" could eventuate in "splenic anæmia." The primary disease must, he thought, be of a severe type, and he would rule out not only rickets as a cause, as Dr. Riviere had done, but congenital syphilis as well. Both these conditions were common in infancy, while splenic anæmia was uncommon, but both diseases were doubtless met with in association with anæmia splenica pseudo-leukæmica infantum. He himself thought the condition was due to a chronic infection of the intestinal tract, but in his experience gastro-intestinal catarrh was not present nearly as often as in the cases quoted by Dr. Riviere; it was absent in nearly half his cases. If it were due to intestinal catarrh, then a suitable diet and skilled feeding should improve the condition, but they did not. Three cases of anæmia in infants were referred to in which the anæmia was of a different type from that of Dr. Riviere's cases, showing that all the anæmias of infancy were not different stages of the same condition. In the first two the anæmia was of the chlorotic type, there was a large leucocyte count, and among them was found a large percentage of polymorphonuclears and a small percentage of lymphocytes. The third case was one of osteomyelitis combined with "splenic anæmia"; there was an increase of leucocytes, and again a large percentage of polymorphonuclears, as well as a fair number of myelocytes. There were two fundamental facts to be remembered in attempting a classification of anæmias; firstly, that the red cells and the white cells in the blood varied quite independently of each other—the diminution of the red cells might be slight while the changes in the leucocytes might be very marked; and secondly, that the changes of the blood in disease were symptomatic and not the primary disease itself. The clinical features of the disease were pallor, hæmorrhages, bleeding from the nose, the gums, and the rectum, and irregular rises of temperature. The duration of the disease was long, the average period in his series of cases being five and a half months. The spleen was enlarged and the liver was apparently enlarged (though after death on being weighed there was but little increase in weight). The superficial glands were not enlarged in any of his cases, but the mesenteric glands were enlarged. Treatment was usually unsuccessful whatever measures were

tried. He thought that if rickets or improper feeding played any important part in the etiology, then the cases should do well, but this was not the case. He considered that the disease was not secondary to any of the conditions described in the paper, and that, indeed, there was no obvious primary cause.

Dr. F. A. Bainbridge referred to the comparison made by Dr. Riviere between splenic anæmia and pernicious anæmia, both being due to the absorption of toxins from the intestine, the toxin in splenic anæmia being assumed to pass into the general circulation, and in pernicious anæmia to be confined to the portal circulation; and remarked, in view of the absence of iron from the liver in splenic anæmia, that in whatever part of the body red blood-corpuscles were destroyed, iron accumulated in the liver. He pointed out that the statement in the paper that toxins absorbed from the intestine were retained by the liver and re-excreted in the bile was hardly probable. In myelogenic leukæmia the percentage of lymphocytes was small.

Mr. L. S. Dudgeon said that the mast-cells were the most important cells in the diagnosis of a myelogenetic leukæmia, and there was no increase of mast-cells in the blood of infants who appeared clinically to be cases of leukæmia. The blood had been of the chlorotic type, with numerous nucleated red cells. The blood had been typical of a secondary anæmia. He also referred to the enormous numbers of nucleated red cells found in the blood in cases of pseudo-leukæmia in children, and to the reduction in the size of the liver and spleen under the administration of arsenic and mercury, pointing to an etiology of congenital syphilis or intestinal infection.

Dr. S. Vere Pearson said that his experience with regard to the occurrence of hæmorrhage in splenic anæmia had been different from Dr. Riviere's, for in four out of five of his cases there were epistaxis, purpura, and bleeding from ulcers on the scalp. He had seen twins both affected by the same disease, showing the need for the investigation of a large series of cases. He thought that Dr. Riviere had not proved the connection between simple anæmia and splenic anæmia, since he had shown no intermediate cases between the two conditions. He thought the condition was a secondary anæmia. He did not think that gastro-intestinal disturbance was an important factor in the etiology of the disease, since such disturbances were common, while splenic anæmia was rare. He had never seen a case of leukæmia in an infant. Splenic anæmia of infants differed from that of adults, but probably both were secondary anæmias.

Dr. A. E. Russell quoted a case of an infant with no diminution in the number of the red blood-corpuscles, with a greatly enlarged spleen, and a very large number of nucleated red cells in the blood. This case, he thought, disposed of the view that nucleated red cells did not appear in the blood unless the degree

of anæmia was severe. The child improved greatly under mercurial inunctions, although there was no definite evidence of congenital syphilis.

Dr. E. P. Baumann said that to a certain extent he was in agreement with Dr. Riviere. His paper might help to remove the custom of many observers of describing as anæmia splenica infantum every case of anæmia in a child in which there were certain blood changes along with some splenic enlargement, or of diagnosing pseudo-leukæmia if leucocytosis were present. The presence of a myelocyte or two, or of a few erythroblasts in a film, did not stamp the blood as that of a case of splenic anæmia. Such abnormal cells were not infrequently met with in the blood of even healthy infants, and the least disturbance of health appeared to facilitate their entrance into the circulation. During the past two years he had had the opportunity of observing the cases admitted as in-patients to the Hospital for Sick Children at Great Ormond Street, and he had found that such secondary anæmias were very common in febrile conditions, such as broncho-pneumonia, and in other diseases, the chief of which were rickets and syphilis. These cases, in his experience, always remained types of secondary anæmia. He believed that there were a number of cases which showed from the beginning the blood changes generally considered to be characteristic of splenic anæmia. The appearance of myelocytes and nucleated red corpuscles, even in large numbers, in a case of enlargement of the spleen were not the leading characteristic, but the polymorphous character of the blood. In addition to the presence of abnormal cells, both finely granular and eosinophile or coarsely granular in type, there was polychromatophilic degeneration, extreme poikilocytosis and marked variation in the size and shape of the red corpuscles. This polymorphous character he had never yet been able to demonstrate in the blood of cases of obvious secondary anæmia, not even when the condition was very severe and ultimately fatal. Whether the disease was a secondary condition or primary, he was convinced that it was an entity, and not merely a late stage of a simple anæmia. So long as undoubted examples of intermediate conditions were not forthcoming the question could not be satisfactorily settled. In regard to the causation of gastro-intestinal catarrh, of seven cases of splenic anæmia admitted to the Hospital for Sick Children in the past eighteen months only three had been exposed to the dangers of artificial feeding; the others had been breast-fed throughout. On the other hand, five cases of the seven presented definite signs of syphilis. In only one case could no signs of congenital syphilis be discovered. Should it be definitely proved that splenic anæmia is a secondary condition, it was probable that syphilis would be found to have an important influence in its causation.

Dr. PARKES WEBER asked if Dr. Riviere knew of many cases of the transition of grave anæmia in adults into leukæmia.

Dr. CLIVE RIVIERE, in reply, remarked that it was easy to affirm, as Dr. Drysdale had done, that when syphilis was present with severe anæmia the association was accidental only; but it seemed to him that the number of reported instances of splenic anæmia with severe syphilis pointed to a dependence in such cases of the former upon the latter. The case described by Dr. Russell, in which the anæmia in such a patient was rapidly cured by inunction of mercury, supported this conclusion. With regard to the cases quoted by Dr. Drysdale as anæmias of other type, the first two were not severe anæmias, and the peculiarities of the differential count among such a large number of leucocytes could be readily explained by the presence of a polymorphonuclear leucocytosis. In the third case the anæmia was more severe, and it might possibly be a case of splenic anæmia with a superadded leucocytosis. Osteomyelitis was a condition in which a leucocytosis was to be expected, and that such could occur in association with a splenic anæmia was suggested by the behaviour of a patient of his own during an attack of pneumonia. The small percentage of lymphocytes in leukæmia of adults referred to by Dr. Bainbridge was a fact, and he had already pointed out in his paper that there were many points of difference between leukæmia in infancy and in adult life; indeed, it had been suggested that they were separate diseases, though he thought there was no evidence of this. Dr. Dudgeon had referred to the absence of any increase of mast-cells in leukæmia infantum. Unfortunately the imperfect blood counts on the cases he had been able to collect from the literature prevented him from saying anything definite on this point. He was pleased to find that Dr. Dudgeon had come to a similar conclusion to his own as to the causative relation of severe syphilis in certain cases to anæmia splenica. With regard to the intermediate cases between slight anæmia and "anæmia splenica infantum" demanded by Dr. Pearson, he would refer him to two of the cases (Nos. 7 and 13) in his table. Any condition slighter than these represented would include an entire absence of myelocytes and nucleated red cells, and would be a simple anæmia of the chlorotic type usually observed.

HYPERTROPHIC PULMONARY OSTEO-ARTHROPATHY

BY

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The condition of certain bones and joints to which this name is now generally applied was not looked upon as a separate entity among bone and joint affections till 1889, when Bamberger demonstrated two cases of bronchiectasis with clubbing of the fingers and painful enlargement of the ends of certain long bones before the Wiener medi-

cinische Gesellschaft (1). In 1891 he added five additional cases, and also four cases of cardiac disease with more or less similar disturbances.

Equal credit is due to Marie (2), who in 1890, only one year later than Bamberger's original paper, and quite independently of him, reported a similar case. He proposed the name Hypertrophic Pulmonary Osteo-arthropathy for the affection, and clearly differentiated it from acromegaly, to which it bears some resemblance. Finally he concluded his paper with some able deductions as to the pathology of the disease, the truth of which other cases which have been published since, and those which I am bringing forward, to a large extent corroborate.

Marie's paper is an important one, but the name which he proposed is cumbrous; hence the condition is sometimes known as "Marie's disease." The chief objection raised to the term hypertrophic pulmonary osteo-arthropathy, apart from its length, is that the disease may occur secondarily to conditions other than pulmonary. However, it usually occurs in connection with pulmonary disease, and the most marked cases accompany bronchiectasis. I have retained the term hypertrophic pulmonary osteo-arthropathy in this paper, but I often follow Walters' (6) plan, and call the disease osteopathy for purposes of brevity.

To Massolongo (3) belongs the credit of coining a better name, "Secondary Hypertrophic Osteo-arthropathy." But, unfortunately, this has not been generally adopted.

The name "Secondary Hyperplastic Osteitis" (Arnold [4]) has the disadvantage of not taking into account the joint changes, which in most cases, clinically at all events, quite overshadow the bony changes.

Thorburn (5) described three cases in tuberculous subjects, and proposed the term "Tubercular Polyarthritis." Many of the cases are free from tuberculous taint, and the name has other obvious disadvantages.

Osteopathy was at first confounded with acromegaly, but in reality the differences are marked and distinctive.

Acromegaly is not so definitely a secondary disease; the pain complained of is very severe, there are marked facial changes, the soft parts are much thickened, there are no joint symptoms, the pituitary body (and usually the thyroid also) is diseased, and finally, the bony changes differ considerably from those found in osteopathy.

The cases on which this paper is based are 82[1] in number; of these 62 are undoubted cases of osteopathy, 10 are in all probability early cases of the disease, and 10 are doubtful cases, or cases intermediate between it and acromegaly and other conditions. The great majority are collected from the literature of the subject. The remainder are made up as follows:—Nine are cases which have recently been in the Brompton Hospital, 1 was in St. George's Hospital in 1898 and 1899, 1 was in the London Hospital in 1901 and 1902, 1 was in St. Thomas's Hospital in 1901, and 4 are published cases which have not hitherto been looked upon as cases of osteopathy. Circumstances prevent my bringing forward 7 of these cases; the remaining 75 will be found tabulated in Appendix A.

Pulmonary osteo-arthropathy is much more common in males than in females. In my series 86 per cent. of the cases were in males, and 14 per cent. in females. The age of the patients shows that it is the middle period of life which is chiefly affected. The following is the age incidence for each ten years worked out from my series:—First decade, 5 per cent.; second, 15 per cent.; third, 23 per cent.; fourth, 32·8 per cent.; fifth, 15 per cent.; sixth, 6·5 per cent.; and seventh, 3 per cent.

Osteopathy occurs in patients suffering from some suppurative disease which is usually in the thorax, from congenital heart disease, or from syphilis.

The appearance of the bony and joint changes of osteopathy is always preceded by clubbing of the fingers, and usually by clubbing of the toes. Sometimes the clubbing does not go beyond that which we are accus-

[1] Six additional cases are tabulated at the end of the paper. This brings the number of cases to 88, and those of undoubted osteopathy to 68.

tomed to associate with chronic pulmonary tuberculosis, and with emphysema and chronic bronchitis. But in the majority of instances, in cases which subsequently develop osteopathy, we find clubbing of a more marked type. The nails are large, broad, and brittle; they are incurved, and the curve is so marked that the name "parrot-beaked clubbing" has been suggested. The thickening of the finger ends takes place in both diameters, transversely and antero-posteriorly. Clubbing of the toes is more marked in the cases of the big and second toes, and it is often confined to these digits. Clubbing of the nose is described, but it must be rare. I have not found it in any of the cases which I have examined.

The interval between the onset of the primary disease and that of the osteopathy varies considerably. It is in many cases difficult to determine, as patients cannot be expected to notice the enlargements in their earlier stages, especially as there is often a complete absence of pain in the parts. An attempt has been made in the synopsis of the cases to determine this interval in each case (q. v.). It will be seen that the period is often six months or a year, but in some cases it is much longer (*e. g.* four years in Cases 36 and 45, seven years in Case 19, and ten years in Case 16). On the other hand, in some cases the osteopathy appeared synchronously with the primary lesion (4, 12, 14, 24), and in two instances the osteopathy developed before the primary disease produced any symptoms (3 and 5).

As a rule the onset of osteopathy is very insidious. Slight stiffness of the joints, particularly the wrists and ankles, is usually the first symptom. In two of the Brompton cases the first thing was stiffness of the ankles, and in a third it was stiffness of the wrists. This stiffness soon involves all four situations.

Stiffness of the knees may be the next manifestation, but in most cases it is preceded by some swelling or discomfort in the joints first affected. This swelling does not begin, as a rule, until three or four months after the

first stiffness of the joint. There may be some pain at the time, but in most cases it hardly merits a stronger term than discomfort. In fact, one patient told me that he noticed swelling of the wrists before he was conscious of any pain, and he did not know that his ankles were affected, although they were found on examination to be typically involved.

Walking is apt to cause aching of the ankle-joints and knees, and using the hands may cause similar results in the wrists. I have only seen one case in which local treatment was called for for the pain.

On examining the extremities at this stage the affected joints show nothing abnormal beyond stiffness, unless effusion is present. Effusion into the knees is often an early sign of involvement of these joints. The interphalangeal joints are seldom swollen, but the metacarpophalangeal joints may be involved, especially those of the thumb and first finger. This also applies to the corresponding situations in the lower extremities. There is no grating in the joints, no œdema is present, and the soft parts are natural. The distal ends of the bones of the forearms and legs give evidence of enlargement, and the metacarpal and metatarsal bones and the phalanges also. In some of the cases there is marked tenderness of the diaphyses of the bones affected.

I may here mention that the cases divide themselves clinically into two groups—

1. *Arthropathy.*—Those in which the joint condition is prominent, and in which enlargement of the bones is present indeed, but would not attract attention unless looked for, as there is no pain or tenderness of the shafts.

2. *Osteopathy.*—Those forming the smaller group, in which there is much tenderness of the bones involved, but in which the joints are only affected from time to time (*e. g.* Cases 35 and 39). I use the term "diaphysial type" when referring to these cases.

The cases will not always be found to fall definitely under one or other of these headings, but the points

referred to should be borne in mind when examining a case.

As the case proceeds the affected joints swell up and become painful and tender from time to time, and there is some swelling of the soft parts around.

The effusion is generally of a more or less passive nature. It may disappear in a few days, or it may last for six months. As a rule no connection between the primary disease and the varying conditions of the joints can be made out. Most interesting deductions, however, are suggested by my first case in this connection. The swelling of the joints is usually accompanied by slight pain and tenderness. Sooner or later the swelling goes down, and the joints cease to be a prominent feature of the case for a time. The swelling recurs after a longer or shorter period, and each attack usually leaves the soft parts round the joint a little more thickened, but this thickening is never really marked. Meanwhile the lower ends of the diaphyses of the tibia, fibula, ulna, and radius gradually become heavy-looking and massive on palpation. In some cases there is enlargement of the lower end of the femur also.

The shafts of the metacarpal and metatarsal bones and the proximal phalanges are thickened and lengthened, and the hands and feet are therefore enlarged. The fact that lengthening occurs has been definitely made out by W. S. Thayer (18), who measured the bones of one of his cases on two occasions, the second observation being rather more than three months later than the first. The question of the condition of the carpal and tarsal bones will be referred to when the post-mortem appearances are considered.

The conditions described continue to become more marked, as a rule, until the primary disease carries off the patient. The wasting of the muscles, due to disuse, renders the enlarged joints and bones more prominent to the eye, and this wasting may give the idea that the osteopathy is progressing faster than is really the case.

If the primary disease improves, the osteopathy may remain stationary and the clubbing of the fingers may disappear. This occurred in my first case (44). Among the cases I have seen, three improved under treatment; they are more or less able to do their work, and their arthropathy, like their primary disease, does not advance materially. Their clubbing remains.

The joint swellings, as indicated above, come and go as a rule in a mysterious manner; when one joint swelling has gone down, either at once or after a longer or shorter period, another is found to be swollen and tender, and perhaps painful.

The blood has seldom been examined in osteopathy. Nothing distinctive has been found, but the hæmoglobin value has always been low.

The urine shows no constant change.

Nervous system.—There is no alteration in the reflexes, no sensory disturbances, and no reaction of degeneration.

Post-mortem Appearances.

The number of careful post-mortem examinations which are recorded is small; there are good accounts in the following instances:—Cases 15, 16, 18, 23, and 40, and in some of Bamberger's cases. Sketchy accounts are given in many instances.

Of the twenty-one post-mortems recorded on undoubted cases, a lesion in the lungs was found in eighteen instances.

The bone changes found bear out those indicated by the skiagraphs (see Appendix B); they nearly always show a definite symmetry, the changes on both sides of the body being practically identical. Of the long bones affected, the distal ends of the shafts show the greatest change, though in some cases the new bone involves the whole shaft of the radius, ulna, tibia, or fibula, as the case may be. Case 23 showed very typical changes. The bones showed periostitis, with deposition of new bone forming a loose friable sheath. There was marked sclerosis of the

cancellous bone of the epiphyses, and the medullary canal was encroached upon by hard bone. In Case 18 the deeper layers of the periosteum contained bony spicules of imperfect bone.

In Case 15 the radius showed deposits of new bone in layers. In Case 23 the small carpal bones showed the same sheath of friable new bone as did the long bones.

Among bones sometimes involved may be mentioned the clavicle, which was enlarged in Cases 4, 6, 17, 21, 31, 35, and 43, the ilia (4, 6, and 43), and the ribs (6, 38, and 43). Finally, enlargement of the acromion and spine of the scapula (6), and of the spinous processes of the vertebræ (6) have been described.

The kyphosis so often associated with osteopathy, apart from the cases associated with spinal caries, is probably postural, and due to the patients being propped up in bed for long periods of time. Scoliosis, when present, is due to the primary thoracic disease.

A chemical examination of a piece of affected bone was made in one case (16). A marked increase was found in the magnesium phosphate at the expense of the calcium salts, and there was also some increase in the organic matter.

The joints showed no changes in Case 40, but in most instances the descriptions of the cases tally well with each other in this respect. The cartilages are eroded in places, but they do not lose their polish. The erosions occur in all the joints which had been involved clinically, and, like the bone lesions, they are, as a rule, symmetrical. In Case 23 the hips, shoulders, knees, elbows, ankles, and wrists were all the seat of erosions. The cancellous bone beneath the erosions is normal; there is no eburnation, and no osteophytic outgrowth. In Thérèse's case and in one of Bamberger's some vacuolation is described in the deeper layers of the cartilage.

The skull bones were thick and hard, and there was no diplöe in Thorburn's case; and in this case, and also in Buzzard's, some abnormality was found in the pituitary

body. The central nervous system is usually normal, as are also the peripheral nerves. The thyroid is occasionally found abnormal. The superficial veins are often thickened.

With regard to the clubbed fingers, the changes chiefly concern the soft parts. No observer has committed himself to a greater extent with regard to bony enlargement of the ungual phalanx than to say that very slight thickening is present. Most observers found the bone normal. As to the soft parts, the following conditions have been found:

Freytag (18) found dilatation of the capillary loops under the nail, with enlargement of the interpapillary processes, but no other alteration in the skin. There was no endarteritis obliterans, and no thickening of nerve sheaths.

Thérèse (16) found slight hypertrophy of the horny layer, papillæ, and connective tissue of the derma. Buzzard (40) found excess of subcutaneous fat in the bulbous end of the fingers.

Case 1.—A. W—, a single woman aged 26, was admitted at the Brompton Hospital on March 27th, 1901, under Dr. Kidd. Eleven years ago she had left pleurisy, but no illnesses before that time. Eighteen months ago she had another slight attack of left pleurisy. At that time an abscess of the left jaw was opened and a wisdom tooth removed.

Family history.—Good.

Present illness.—Cough with expectoration for twelve months. The first six months the expectoration was scanty but offensive, the last six months copious and very offensive. Pain in left side prominent throughout. Hæmoptysis, 2 oz., six months ago, and again (about same quantity) once or twice since. Some loss of flesh; occasional night-sweats. Catamenia irregular; occasional swelling of the wrists and ankles for five months.

On examination well-marked signs of bronchiectasis

were found on the left base; marked clubbing of fingers, joints normal.

Shown before Clinical Society October 26th, 1901. At this time both wrists were swollen, stiff, and tender, fingers generally enlarged, tips clubbed. Interossei and forearm muscles wasted; knees slightly swollen and contain a little fluid. Ankles large, but not tender at present. Muscles of legs, especially extensors, wasted. Feet in the position of talipes equinus, but ankles can be dorsiflexed. During this period sputum has not markedly diminished in amount, though it is no longer offensive. There has been some loss of weight. The X rays show slight changes in hands, forearms, and femora. Patient was discharged soon after this, and died in December, 1902. No post-mortem examination.

The treatment consisted in daily creosote vapour baths, creosote 1 to 5 minims by the mouth, and general measures.

(For account of arthropathy and for charts see pages 100—103.)

Case 2.—E. F—, a married woman aged 32, was admitted October 16th, 1901, to the Brompton Hospital, under Dr. Green. She had had bronchiectasis for four years, and complained of continuous loss of flesh and strength, much expectoration, and of hæmoptysis, 1 oz., last winter. The family history presented nothing special. Previous history—healthy.

On examination.—A thin, weak woman, orthopnœic and sallow. There were marked bronchiectatic signs over the right lower lobe. Expectoration extremely offensive. The amount first week was 185 oz., second 191 oz., third 205 oz., fourth 212 oz. There was clubbing of the fingers and toes, which had been observed for two years, and swelling, pain, and tenderness of right wrist, which she had noticed for two months.

The treatment consisted of creosote vapour baths, half to one hour daily, 3 minims of creosote by the mouth three times a day, and general measures.

Death took place on November 22nd from left pleuro-pneumonia. No post-mortem examination.

CASE 3.—I am giving this case in some detail, as it was shown before the Clinical Society when it first came under observation as a case of osteopathy without pulmonary lesion. (For skiagraphs, see 'Clin. Soc. Trans.')

A. K—, a married woman aged 36, was admitted at the London Hospital on April 17th, 1901, under Dr. Warner.

She was at one time subject to hysterical fits. She had suffered for five years from sciatica. There was no history or evidence of syphilis and no history of pulmonary disease.

The father died at forty-eight, apparently from heart disease. He had had rheumatic fever. Otherwise family history good. No pulmonary tuberculosis.

Her present illness dates from eighteen months ago, when she had a bad attack of influenza lasting a fortnight. As the influenza improved her knees became painful, and she could not kneel. A little later clubbing of the fingers was noticed, and since then this has continuously become more marked. Twelve months ago her feet and ankles were swollen. There has been considerable pain lately, which has been worse after exertion. The pain in the hands is described as aching and dull, sometimes tingling like an electric battery; that in the feet and legs is as if they are about to burst. She has lost 4 st. 4 lbs. in weight. She had a slight cough with expectoration three months ago, and brought up a little blood after sea-sickness.

On examination she was much wasted, but not markedly anæmic. Lungs normal; no cough or expectoration. Heart normal except for accentuation of the pulmonary second sound. One observer, however, reported, "Apex-beat certainly displaced out. Resistance to finger seems greater, and pitch of percussion note seems slightly higher in second and third left interspaces; but difference, if present, is very slight."

Thyroid normal, ears normal. Nose, patient says, has become larger at the tip lately. Eye movements, pupil

reactions, fundi, and field of vision normal. Hands—dilatation of veins. Hands are thick and broad. She used to take No. 7 gloves, but now cannot get gloves to fit. Terminal phalanges clubbed, and nails incurved though not striated. Considerable thickening round mid-phalangeal and meta-carpo-phalangeal joints. Skin shiny. Thickening of metacarpus and phalangeal bones. Slight effusion into wrist-joints. Marked thickening of lower third of forearm bones. Fine tremor of fingers—movements of fingers impaired. Marked wasting of interossei and of the thenar and hypothenar eminences. No abduction of hand or grating. The toes are thickened like the fingers, but to a less degree. Tarsus and metatarsus thickened. Slight effusion into ankle-joints. Tibiæ and fibulæ thick and broad, especially the lower thirds and heads of tibiæ. Marked effusion into both knee-joints—very free movement at the knee and considerable lateral movement. Wasting of thigh muscles. Kyphosis present, but no scoliosis. Electrical reactions in proportion to wasting, but no R.D. No enlarged glands. P.V. *nil* abnormal. Catamenia regular up to two months ago. Bowels regular, appetite fair. Urine 1020; no albumen or sugar.

Patient's condition remained about the same while in hospital. Discharged May 15th.

Readmitted April 19th, 1902.—A marked change in the patient since last in hospital. Emaciation extreme; the face has almost a masculine appearance, with large black bushy eyebrows, a full moustache, whiskers, and beard; skin thickened. Cough with expectoration for nine months. Night-sweats. Diarrhœa for eight weeks; no vomiting. The osteopathy is less marked, but the legs are tender. Face dusky. She is too weak to examine thoroughly. Right side of the chest moves more than the left. Heart-sounds clear. Lungs: dulness, with signs of cavity at left apex. Over left second rib in front is a small cystic tumour. Abdomen nothing abnormal. Some fluid in left knee, none in ankles. Dilated veins over shins; thickening irregular and painful over the whole of the tibiæ.

Lower third of femora thickened. Tarsal and metatarsal changes not marked. Arms: no fluid in joints; thickening of the whole of the left ulna and lower third of right ulna. Radii and metacarpal bones slightly enlarged. Humeri nothing abnormal.

Post-mortem.—Right pleura normal. Left pleura everywhere adherent by soft new growth, which bulges through the second rib to form the prominence noticed before death. On section it is greyish red, and there are small spots of hæmorrhage and little foci of pus. Left lung: the primary growth (carcinoma undergoing colloid degeneration) is situated at the bifurcation of the left bronchus, and originated in the bronchial glands. It is an inch in diameter. The lung is studded with secondary growths. Right lung studded with hard, shotty, secondary deposits. Heart normal. Abdomen: no fluid, no lardaceous disease; left hydrosalpinx, otherwise organs normal. The thyroid was normal. The bones and joints, unfortunately, were not examined carefully for osteopathy. A little thickening of the right tibia was, however, found, and on opening up the left knee-joint the cartilages of the femur, tibia, and patella were irregularly eroded.

Case 4.—M. M—, a girl aged 10, admitted at St. Thomas's Hospital on January 31st, 1901, under Dr. Mackenzie.

Family history.—Father and mother healthy and well. Six brothers and sisters out of nine died of pneumonia following measles. No further evidence of tuberculosis.

Past personal history.—Well up to three years ago, when she injured her back in a fall. Three months later angular curvature and loss of flesh was observed, and she was put up in a plaster-of-Paris jacket. From this time up to admission she had been under continuous treatment for her spine.

Present illness.—Nine months ago the abdomen was observed to be getting larger; since that time this swelling has continuously increased, and she has complained of pain in the abdomen and hips. For the last three weeks

she has been restless and fretful, and swelling of the legs, feet, toes, wrists, and finger-tips has been noticed.

On admission.—A pale, feebly nourished child with caries of the spine. Abdomen prominent, especially so in the upper part. Umbilicus and veins prominent; a little fluid present. Liver large, reaching below umbilicus; upper level of dulness normal. The spleen reached one inch below costal margin. Chest badly developed; signs of old rickets present. Respiration shallow and difficult owing to abdominal enlargement. Heart-sounds normal but weak. Lungs: some hyper-resonance right upper lobe, and dulness below fifth rib in right axilla; otherwise normal. Legs thin; knee-jerks normal. Plantar reflexes brisk, flexor response. Sphincters normal. Ankles and feet swollen. Toes much enlarged and markedly clubbed. No œdema. Wrists much enlarged, especially the left. Fingers and thumbs show marked clubbing. Urine 1020; albumen, a trace; a few hyaline casts; no sugar.

The condition of the patient gradually became worse; the distension of the abdomen increased, and respiration was progressively embarrassed (although she was tapped three times), and the bases of the lungs became engorged. Diarrhœa was troublesome. She died on April 9th.

Treatment.—Two minims of Liq. Arsenicalis and two drachms of cod-liver oil were given three times a day for two months.

The temperature was sometimes continuously raised, reading about 99·5°, but it was usually of the subfebrile type; the evening reading, however, was sometimes above 100°.

Post-mortem.—The bones forming the dorsal angular curvature were found when cut into to be quite soft, and to contain in places cavities filled with blood-stained *débris*. There was one flake of dead bone, but no suppuration. The heart was normal. No disease was found in the lungs, but the right lower lobe was collapsed. The liver and spleen showed great uniform enlargement. The liver, spleen, stomach, and intestines were waxy. No

ulceration of gut. No evidence of syphilis was found. No examination of the bones was made, but the clubbing continued to be very marked post mortem.

The three plates are from this case. They show the periosteal new bone of osteo-arthropathy exceptionally well. Although no actual disease of the lungs was found post mortem, they had been embarrassed for long periods of time, the rickets, the spinal caries, and the enlarged abdomen being responsible for this at different periods. Owing to its late inclusion in the paper no further comment on this case will be made.

NOTE.—For Case 5 see Appendix C.

ETIOLOGY.

Bamberger in his original paper spoke of the dependence of osteopathy on the absorption of putrefying bronchial secretion; but he suggested the probability of several causes being at work, and he spoke very guardedly. He quoted the experiments of Wegner, who produced changes similar to osteopathy in hens by feeding them with phosphorus. He also mentioned his own experiments in which he made rectal injections of putrefying bronchial secretion into rabbits without positive results.

Marie was bolder in taking up the toxic theory. He summarised the cycle of changes under three headings: (1) a lesion of the respiratory apparatus, allowing the production of putrid or fermenting substances under the influence of micro-organisms; (2) the absorption and passage into the general circulation of these products; (3) an elective action of these substances on certain parts of the bones and joints.

Massalongo thought that the disease may be secondary to many conditions, but that the arthritic diathesis plays the principal *rôle*. The cases which I have seen do not bear out this view, careful inquiries having failed to bring out evidence of gout or rheumatism in the patient or family in every instance except one. This patient was the subject of gout and rheumatism.

Thorburn considered that we are dealing with an exceedingly chronic form of tuberculosis.

The evidence from the cases which have been published during the last thirteen years (see Appendix A) seems to bear out the truth of the toxic theory set forth by Marie and Bamberger. My cases certainly support this view.

My first case affords striking evidence in favour of the toxic theory. I showed the case, which was one of sacculated bronchiectasis, before the Clinical Society in October, 1901.

Now there are two main types of bronchiectasis, the "fusiform" and the "sacculated." The fusiform is the one usually met with, the sacculated variety constituting only a small proportion of the cases. The subject of bronchiectasis cannot be entered into in this paper. Suffice it to say that in fusiform bronchiectasis the patient is daily ejecting sputum which does not vary much in amount; hence the amount of putrescible material in the lungs does not appreciably alter from day to day. On the other hand, in the sacculated variety there are periods during which the pulmonary cavities are filling up and but little sputum is evacuated, followed by bulky evacuations of the putrefying bronchial contents. In these cases, therefore, there may be a large quantity of sputum in the lungs one day, and on the next the cavities may be almost empty. Since sacculated bronchiectasis is the less usual variety of the disease, osteopathy complicating it will be only rarely met with. Hence it is, probably, that the following observations were not made before this case came under notice.

Whenever she evacuated her large cavities the joint conditions, which had been becoming more troublesome for a week or two, rapidly subsided, the pain and swelling disappeared, and her general condition immensely improved. Part of the temperature chart is appended; the bulky daily evacuations (43 and 50 ounces in the cases instanced) will be seen to be followed by a remarkable fall in temperature. After these bouts she invariably improved for a time; she did not vomit, which had been a

distressing feature of the case, she took her food well, and enjoyed life in a way which at other times was impossible.

The following is the history of the arthropathy in this case. The end of each acute joint attack was marked by a bulky evacuation of sputum.

First attack.—This came on in October, 1900. The first symptom was stiffness of the ankles, which were swollen the next day. This condition persisted for six months, but there was no pain. At Christmas the hands became swollen and painful, and in March the knees became stiff. She brought up a large amount of bronchiectatic sputum on March 26th, and on the 29th all the joints were practically normal. Duration, six months.

Second attack.—On March 1st the right wrist and fingers (all three phalanges), the right knee, and both ankles became swollen and tender. The left wrist followed in a few hours. Duration, fifteen days.

Third attack.—On June 19th there was a recurrence of swelling, stiffness, and pain, but no tenderness of the wrists, knees, and ankles. Duration, twenty days.

Fourth attack.—On this occasion (July 15th) the right wrist, right knee, and left ankle were especially affected. Duration, one month. (See Chart 1.)

Fifth attack.—On September 8th there was a return of pain, swelling, and tenderness of the right wrist. Duration, a few days. (See Chart 2.)

Sixth attack.—The right wrist and ankle were affected on September 24th. Duration, a few days.

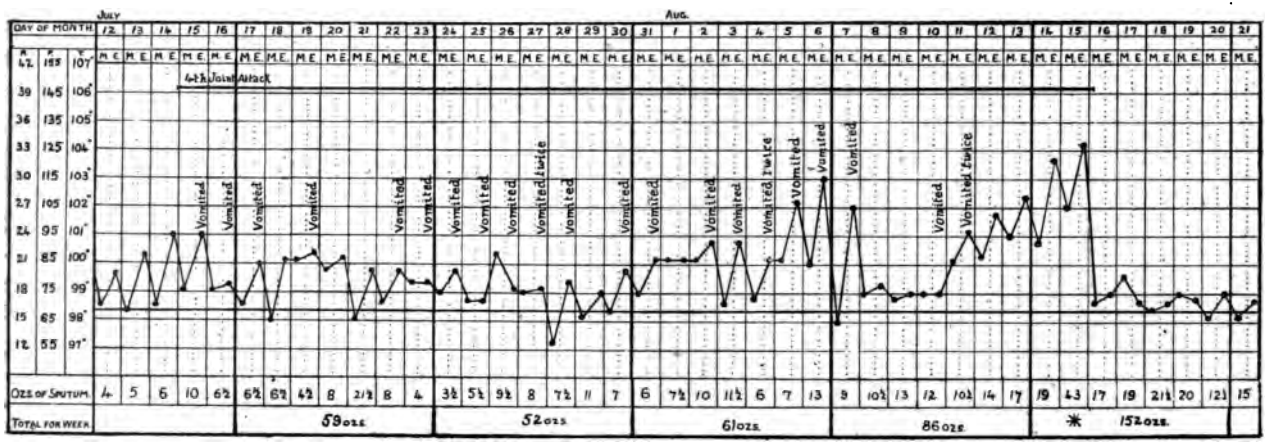
Seventh attack.—A more chronic exacerbation began on October 15th, during which the patient left the hospital.

After each of the above periods of acute arthropathy a little more permanent periarticular thickening remained.

Another bronchiectatic patient told me that the joints were always more painful when only a small amount of expectoration was being brought up.

This evidence makes it clear, to my mind at all events, that the osteopathy is dependent in these cases on the

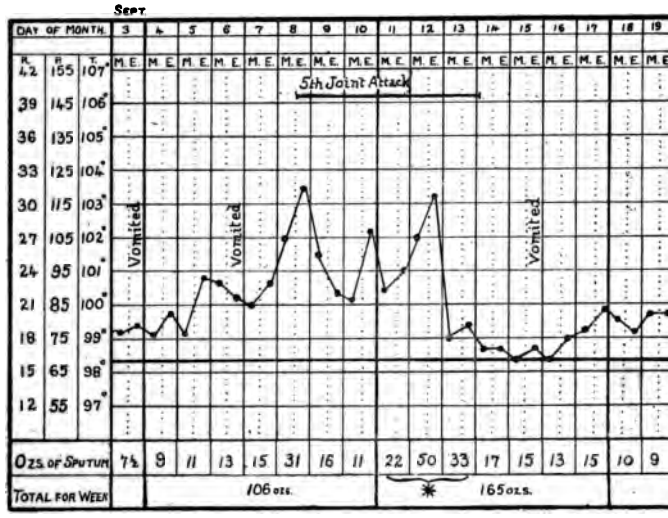
Chart 1.



Fourth joint attack.

focus of the lungs. That it is toxic rather than septic, *i. e.* that toxins only and not organisms are present in the parts involved, is probable, as the joints never suppurate. From the experiments of Poynton and Paine, however, this argument would not seem to be final, as in their work on rheumatoid arthritis (59) they have found organisms in the joints which do not cause suppuration.

CHART 2.



Fifth joint attack.

That it is inflammatory is, I think, also beyond question. The heat, tenderness, and pain, though not marked, are often undoubted; and I have seen a case in which there was a swollen lymphatic gland in the axilla as big as a hen's egg when the right wrist was swollen and painful, and there were lumps in the groin when the joints of the lower extremities were in an acute stage. These swellings disappeared when the joint trouble abated.

Again, the parts affected by osteopathy afford further support to the toxic theory. They are the joint tissues

and bones. That toxic manifestations should show themselves early here is what we should expect, for these are the parts where the circulation is slowest, and where the blood is longest in contact with the tissues.

Let us now consider what we know about the fate of toxins developed in an imaginary infective focus—

(A) In the lungs.
(B) In the portal area.
(C) In the peripheral area.

(A) *A Toxic Focus in the Lungs.*

The evidence goes to show that deleterious substances other than carbon dioxide are removed in large quantities in normal respiration with the expired air. Brown-Séquard's and d'Arsonval's experiments (15) show that respiration adds to air toxic matters, other than carbon dioxide, which are a direct menace to life. Those rabbits which breathed expired air died, but those which breathed expired air which had passed through sulphuric acid survived. In health, therefore, toxic matters are eliminated by the lungs.

In a disease of the lungs in which poisons are developed—and we will take bronchiectasis as the type,—we have: (1) the amount of toxins produced increased; (2) the area available for respiratory exchange diminished; (3) congestion of the healthy parts of the lungs, impeding their work, and with it their eliminating function.

It is interesting to note that in most cases of osteopathy dyspnœa is a rather prominent feature. In health all the volatile deleterious substances are probably removed from the blood while it is in the pulmonary capillaries, and the lungs are no doubt capable of dealing with an increased amount of poison on occasion, being possessed, like other parts of the human mechanism, of some reserve power. In disease the capillaries have to eliminate not only the toxins of normal metabolism, but also those produced in the toxic focus; and there comes a time when, either owing to

the large amount of toxins produced or to the diminution of the area of the lungs available for respiration, or to both causes combined, that the expired air cannot carry away all the volatile toxins which are present in the blood. Then it is that the excess of these products is carried on to the pulmonary veins, whence they are rapidly driven through the left heart to the peripheral area. The poisons will reach the systemic capillaries practically unaltered, for the only modifying influences to which they have been subject on the way will be those exerted by the blood, and these will have been operative for a very short time only. The result of this lessened elimination will be an accumulation of toxins in the blood.

(B) *A Toxic Focus in the Portal Area.*

Chronic diarrhœa is the best instance of this. In diarrhœa the number of micro-organisms in the alimentary canal is enormous, and the amount of toxins produced very great. Some toxins will be carried off by the lymphatics, but a large amount will be taken by the radicles of the portal vein to the liver. This great organ has remarkable detoxicating properties, and even in health it is constantly modifying, by synthetic and oxidising processes, substances from the alimentary canal which would otherwise be most harmful.

The greater part of the intestinal toxins, then, having passed through the epithelial cells of the intestinal wall, enter the radicles of the portal vein, are carried to the liver, and do not reach the inferior vena cava until they have traversed the hepatic capillaries. The liver is the most important detoxicating organ in the body, and from its position as sentry on the portal system it is of special importance in eliminating intestinal toxins, acting as a screen to the delicate cells of the body beyond. It must not be supposed that the liver is the only detoxicating centre. The epithelial cells of the intestine have impor-

tant functions of this nature, and the kidneys, the spleen, and the muscles share in the work.

Among the synthetic and oxidising processes which the liver is daily carrying on, the following may be mentioned:—Changing ammonia into urea, indol into indoxyl and indoxyl sulphate, and phenol into phenyl sulphate. Experiments show that extracts of typhoid bacilli injected into the portal vein become less active, and that tetanus toxin similarly introduced is neutralised. Nicotine added to the portal blood is not recoverable from the circulation. Hyoscyamine, strychnine, morphine, and certain metals (such as Cu, Sb, Fe, Ag, and Hg) are stored or altered by the liver (17). I shall have to revert to this subject when I bring forward certain cases of osteopathy complicating excessive fermentation and putrefaction in the intestinal tract.

(c) *A Toxic Focus in the Peripheral Area.*

In such a case the toxic products, except such as go through the lymph channels and are altered in the lymphatic glands, will pass straight to the lungs, where such of them as are volatile will be got rid of. The non-volatile toxins will be carried on to the general circulation, and will be detoxicated by the cells of the liver and other organs.

Let us now examine severally the diseases secondary to which osteopathy has developed, and see to what extent the sequence can be accounted for in each case. Of my series of 82 cases, 62 were undoubted cases of osteopathy. In some of these more than one disease was present, and one cannot speak definitely as to what was the primary cause, and in two or three cases the osteopathy itself appeared to be primary. Setting these two doubtful classes aside for the present, I append a list of those cases in which there was only one primary disease present, and in which the causal relationship seemed undoubted.

(*a*) *Pulmonary :*

Bronchiectasis	13 cases.
Empyema	8 „
Chronic pulmonary tuberculosis	6 „
Malignant disease in thorax	2 „
Pneumonia	2 „
Bronchitis	1 case.
Pleurisy with effusion	1 „
	33 cases.

(*b*) *Non-pulmonary :*

Syphilis	4 cases
Heart disease	2 „
Diarrhœa	4 „
	10 „

It will be seen that of this number 33 cases were pulmonary and 10 were not. I shall show that the heart cases are probably pulmonary also, as the heart lesion profoundly modifies the conditions in the lungs. If the heart cases are placed in the pulmonary list the pulmonary cases predominate still more, the numbers reading 35 to 8. There were twenty-one post-mortem examinations in my series. Of these only three showed normal lungs, and in only one case were both heart and lungs normal.

To take the primary diseases separately :

Bronchiectasis.—This is not only the commonest cause of osteopathy, but it also affords the most typical examples of the disease. It is the disease *par excellence* of a chronic pulmonary suppuration. The bronchiectatic cavities contain streptococci, staphylococci, and diplococci, as well as many varieties of putrefactive organisms.

Empyema is more often the forerunner of osteopathy when the cavity is connected with the outer air either through an operation wound or by way of a bronchial fistula. It will be observed that this condition affords an almost exactly similar nidus for bacterial life as bronchiectasis. Six out of the eight cases which fall under this

heading are of this nature, and osteopathy developed secondarily to closed empyemata in two instances only.

Chronic pulmonary tuberculosis appeared to be the undoubted cause in only six cases. One of these (4) was an advanced basal case with excavation. No doubt extensive secondary infection occurred, and it may be dismissed with the remark that it differs but little from bronchiectasis. It is probable that in the majority of the remaining five cases the pulmonary tuberculosis was not the only cause of the osteopathy.

Tubercle being such a common chronic disease of the lungs, we should expect *a priori* to find it in causal relationship to osteopathy. Nevertheless I can only make out such a connection in a small minority of the cases (6 out of 53), and when this question is subject to the safer evidence of the autopsy the minority becomes still more insignificant (1 out of 21).

Of the twenty-one autopsies tubercle was found in the lungs in eight instances. In six of these the tubercle was either very early or obsolete, whilst a quite adequate cause of osteopathy was present elsewhere. Of the remaining two cases, one was the advanced basal case above mentioned, which may be classed for present purposes with bronchiectasis. The only case left (16) was an ordinary case of pulmonary tuberculosis with excavation. In fact, this was the only one of the twenty-one cases which could be said to be secondary to pulmonary tuberculosis of the ordinary apical variety.

In pulmonary tuberculosis the continuous cough brings up the sputum rapidly, and, except in the uncommon cases of basal disease, the sputum is expelled before there has been time for much bacterial action in it. The putrescible focus of bronchiectasis is therefore absent in this disease, and this fact probably accounts for the light incidence of osteopathy in pulmonary tuberculosis. The clubbing of the fingers which is found in some cases is probably the result of the slight toxæmia which the tubercle bacillus and secondary organisms are capable of developing from the

sputa in the short time available. If this is so, the marked or "parrot-beaked" clubbing which is found in osteopathy is evidence in favour of the toxic origin of the disease.

But the *rôle* of pulmonary tuberculosis in osteopathy is probably an important one, though it seldom produces it acting alone. It is remarkable how often pulmonary tuberculosis is found in my series in association with other conditions, such as chronic diarrhœa, caries of the spine, and necrosis of the ribs. The chronic pulmonary tuberculosis often comes on later, and appears to determine osteopathy. When a toxic focus exists elsewhere the appearance of tubercle in the lungs, lessening the area available for respiratory interchange, and so the amount of volatile toxins eliminated, probably acts as an adjuvant, bringing on osteopathy when it could not have done so acting alone.

Further, setting aside osteopathy for the moment, there is no special connection between chronic pulmonary tuberculosis and joint disease; in fact, a kind of antagonism appears to exist between them. It seems that people subject to joint dyscrasiæ are not subject to pulmonary tuberculosis. It is a well-known observation that a lowering influence which in one case is the starting-point of pulmonary tubercolosis, in another ushers in rheumatoid arthritis. In fact, if a weak point exists in a given individual, it may be in the joints or in the lungs, but it will seldom be in both.

Clinical experience shows that joint complications in pulmonary tuberculosis are very unusual. My observations on this subject at the Brompton Hospital strongly bear out this statement. I kept a careful watch for joint pains and swelling in 100 consecutive cases of pulmonary tuberculosis. The cases were in all stages of the disease, and each was observed for a period of three months. In this series only one patient developed joint pains. In this case, in which the lung mischief was in an early stage, the pain only lasted for two days; it was accompanied by slight pyrexia (99°—100°), and the attack was probably

influenzal in nature. The patient gave no history of gout or rheumatism, or of any previous arthritic manifestations.

Croftan's results (20) were equally striking. In 200 consecutive cases of advanced pulmonary tuberculosis he only found three with arthritic manifestations. Conversely he found only one patient who had ever had pulmonary tuberculosis in 100 consecutive arthritic cases in the Philadelphia hospitals. It has long been recognised how seldom it is that pulmonary tuberculosis develops in lithæmic patients.

Malignant disease in the thorax was the cause in Cases 2, 43, and probably 41. Such growths no doubt produce toxic products, but in the present state of our knowledge of malignant disease I will not pursue this subject.

On *pneumonia* (3) and *bronchitis* (29) nothing further need be said.

Pleurisy with effusion (34) affords favourable conditions for osteopathy. The fluid no doubt contains toxic substances; it is at high pressure, which facilitates absorption, and the respiratory area is much lessened. This disease is seldom present long enough for osteopathy to develop.

It must be admitted that osteopathy may be caused by non-pulmonary diseases. Certain cases of this nature will now be considered. They may be classified as follows:

1. Congenital heart disease.
2. Syphilis.
3. Toxic foci (other than pulmonary); of these the most important are diarrhœa and psoas abscess.

Congenital heart disease is occasionally the primary cause. In my series five cases (50—54) are put down under this heading. Two of these had active tuberculosis of the lungs at the time of death. All five cases were looked upon as secondary to heart disease by their authors; and the cases have their full value, as post-mortem examinations were made in each instance. Four of them were published by Bamberger, and a beautiful engraving of some of the bones showing the osteophytes will be found in his paper. In Cases 50 and 54 the lungs were normal.

Congenital heart disease may be looked upon as a lung disease also, as the conditions present in the lungs depart far from the normal. The congestion present must hinder the elimination of waste products with the expired air, and thus we have reason to suppose that the blood in the systemic circulation is toxic in character. We know that the blood presents marked abnormalities. There is a high corpuscular count and hæmoglobin value, and there are probably many finer changes present which we cannot determine with our present methods.

Syphilis was the cause of osteopathy in four cases (46—49). Two of these occurred in the congenital variety, and two in the acquired disease. It would not be profitable to discuss the pathology of osteopathy in this disease. The number of cases of osteopathy with a history of syphilis is necessarily difficult to determine. I have looked into this point in as many cases as possible, and do not think it is often present.

Of toxic foci other than pulmonary we will first consider *spinal caries*. My series does not include a case of arthropathy developing secondarily to spinal caries acting alone. Nevertheless it was present in either a quiescent or active state in quite a number of the cases (*e. g.* 23, 32, 38, 39, and 40). In many of these pulmonary tuberculosis developed later, and the two causes acting together seemed to produce the arthropathy.

These facts fall in well with the theoretical considerations detailed above. The toxic substances only produce osteopathy when something interferes with the eliminating function of the lungs. As long as they were sound the lungs were able to take on increased eliminating work, but when they became diseased poison was poured into the general circulation, causing arthropathy.

Chronic diarrhœa.—This is an interesting cause in view of what has been said above under "A Toxic Focus in the Portal Area." It was present in the following cases:—6, 7, 25, 27, and 28. I have seen two cases which were the subjects of diarrhœa throughout. The diarrhœa appeared

to be a contributing factor, and it, acting together with the bronchiectasis, presumably brought on the osteopathy, which probably would not have been the case had the diarrhœa existed alone. Albuminuria was absent in both instances. Thorburn's third case followed diarrhœa and pulmonary tuberculosis of a few months' duration only.

In view of these cases and our knowledge of the powerful detoxicating action of the healthy liver, it is to be expected that osteopathy would tend to develop in conditions associated with excessive fermentation and putrefaction in the alimentary canal, together with disease of the liver. Such a combination we have in cirrhosis. I venture to think, from a study of the literature of the subject, that one of the varieties of cirrhosis of the liver is occasionally associated with osteopathy. I refer to hypertrophic biliary cirrhosis in children.

H. R. Smith (23), in a recent paper on cirrhosis in children, divides his seven cases into two forms—atrophic and hypertrophic. The atrophic form was rapidly fatal, the patients dying respectively in twenty days, eight days, four and a half months, and one month after the onset of the symptoms. In the hypertrophic form, which presented a fairly definite clinical picture, the patients survived for a much longer period, viz. ten, one, and five years respectively. Gilbert and Fournier (24) had, three years previously, described seven cases of hypertrophic biliary cirrhosis in children which closely correspond with Smith's three cases. In the same year Dr. Taylor (25) published three cases of cirrhosis in children, one of which was very similar to the hypertrophic variety of the other authors in its characters and history.

The bone and joint changes observed in these cases were the following. The other features, which were quite definite, do not specially concern us here.

Gilbert and Fournier's cases. Case 1.—"The ungual phalanges were voluminous, swollen, and clubbed. The lower end of the femur and the ends of the tibia were

also enlarged; the knees were painful and contained fluid."

Case 2.—"The ungual phalanges were enlarged."

Case 3.—"The wrists and tibio-tarsal articulation were painful."

Dr. Taylor's case was accompanied by slight enlargement of the finger ends.

It will be observed that Cases 1 and 3 presented fairly typical pictures of osteopathy, and from the evidence which they afford as to the clinical history of the disease, it is probable that Case 2 and Dr. Taylor's case were instances of osteopathy in an earlier stage.

Most of the above cases of cirrhosis in children were accompanied by fever, and followed catarrhal enteritis. The rapid course of the atrophic cases may account for the absence of osteopathy in this variety, time not being allowed for it to develop. The fact that adults do not depend so exclusively on the liver as children, whose spleen, kidneys, and muscles have not developed detoxicating functions (17), may account for the freedom of adults from osteopathy following cirrhosis.

It only remains to consider the cases of osteopathy in which the authors considered that there was no adequate cause for the disease. My series provides three cases of this nature.

The first is that of a woman (Case 3, p. 95), whose organs I was enabled to see post mortem through the kindness of Dr. Bertrand Dawson. This case was shown before the Clinical Society in 1901. Well-marked osteopathy was present, and this was confirmed by skiagraphs. At that time the general opinion was that the lungs were normal, although it was noted that the pulmonary second sound was accentuated, and that the apex-beat was in the nipple line. It is significant that one observer thought he detected some impairment of the percussion note over the second and third left interspaces in front. When she was readmitted a year later the movement of the left chest was impaired, dulness was

present, and malignant disease was diagnosed. She died in April, 1902. A malignant growth was found which had originated at the bifurcation of the left bronchus, secondary deposits being present all over the lungs. The osteopathy had retrogressed during the later stages of the case, but what was found post mortem was typical of the disease. This case was originally brought forward as one of osteopathy without pulmonary lesion, and as such attracted some attention. In view of the sequel the opinion may certainly be held that the malignant growth existed all along. The bifurcation of the left bronchus is deep in the chest, and a mass in that situation would not necessarily give rise to physical signs.

The second is Lockwood's case (39). This patient presented certain pulmonary signs over the meaning of which observers differed. The pulmonary basal signs in this case may have been due to the extension of the inflammation from the carious spine, which had become quiescent when the patient was under observation, *i. e.* to a septic focus at the right base. No post-mortem examination was made.

No great stress need be laid on these two cases. The thoracic conditions were too obscure for deductions to be safely drawn from them. They illustrate once more the importance of a post-mortem examination before passing a verdict. A mediastinitis or a diaphragmatic pleurisy or empyema might remain undetected clinically. Again, osteopathy without apparent cause might occur—if the toxic theory is true—secondarily to a very small toxic focus occurring in a patient with special bone and joint susceptibility.

The third is Case 21, the subject of carcinoma of the parotid. Osteopathy appeared in this instance before ulceration took place in the growth, and the heart and lungs were found normal post mortem. The thyroid and the pituitary body were, however, enlarged. Abnormalities of these organs were found in several of the autopsies of my series, as well as in this obscure case.

Bacteriology.

It has been indicated that the flora in most of the conditions to which osteopathy is secondary are many and various. Bronchiectatic cavities contain very diverse varieties. Such conditions prevail (though the dressings no doubt exclude many organisms) in psoas abscesses which have been opened; and the micro-organisms of the intestine are still more numerous.

The bacteriology of pulmonary osteo-arthropathy is at present virgin soil, and I have been obliged to put this matter on one side. It is probable that many organisms can cause osteopathy, and that in most cases several are acting jointly. Whether we have to deal with the actual organisms circulating in the blood or only with their toxins is a moot point. Most micro-organisms sooner or later cause softening or suppuration. The absence of such changes in osteopathy is therefore in favour of the toxins only being present in the bones and joints. The definite symmetry of the disease is also in favour of a toxæmia. The eroded condition of the joint cartilages is further evidence, as the appearances suggest chemical solution rather than inflammation, which the actual organisms would probable cause.

Pneumococci and a few streptococci were found in the pus in one case, and *Bacterium coli communis* was found in the urine in Marfan's nephritic case (61).

In most of the conditions preceding arthropathy aërobic organisms predominate, *e. g.* in bronchiectasis, in empyema with sinus, in discharging psoas abscess, and in intestinal putrefactions.

There is an analogy between pulmonary osteo-arthropathy and waxy disease. Waxy disease is the result of poisoning brought about by chronic suppuration and by syphilis. Many organisms are probably capable of inducing it, and two varieties have been proved, by injection experiments, to have a causal relationship to it in animals —namely, *Staphylococcus pyogenes aureus* and *Bacillus*

pyocyaneus. Positive results were obtained with the former by Krawkow (54), Davidsohn (55), and Green (14), and with the latter by Charrin (56). It is probable that many varieties of organisms are concerned in the production of both diseases, some of them giving rise to waxy disease and others to osteopathy. Case 41 is in favour of this view, as osteopathy was present, but there was no waxy disease found at the autopsy. It should be mentioned that waxy disease is generally found at the post-mortem examination in cases of osteopathy, but it is not present, as a rule, in an advanced stage. This is borne out by the clinical history of the cases, as waxy disease is seldom diagnosed during life.

Syphilis is the meeting ground between pulmonary osteo-arthropathy and waxy disease. In certain cases it produces the one, and in other cases the other.

Diagnosis.

The only difficulty here is the rarity of the disease. It has no doubt been often mistaken for rheumatism in the past. The tendency to put down all obscure joint conditions to rheumatism is a convenient habit which is no doubt responsible for this. Now that we are beginning to differentiate joint affections more accurately this mistake will not occur so often. The same remarks apply with hardly less force to gout.

The diagnosis of osteopathy from osteo-arthritis would be made from the absence of lipping and of the characteristic creaking; and from Charcot's joint, from the absence of increased mobility, and of evidences of tabes dorsalis.

Tuberculous joints will be probably asymmetrical, and they will be separated from osteopathy by means of the history, and by their characteristic features.

Gummata and syphilitic bony growths may cause difficulty. Potassium iodide should be tried in doubtful cases.

The forms of arthritis associated with acute infections such as typhoid, scarlet fever, pneumonia, influenza, gonorrhœa,

and pyæmia will seldom be confounded with osteopathy. They are often monarticular, and are usually suppurative. Pneumococcal arthritis without suppuration has been observed (52, 53), and I have recently seen a case of influenzal arthritis which was quite suggestive of osteopathy for a time (58). In this type of case the presence of the corresponding acute disease, or a history of a recent attack, and in cases of effusion the bacteriological examination of the joint fluid, will clear up the diagnosis.

Many of the points differentiating osteopathy from acromegaly have already been given. The fact that acromegaly is clinically a primary disease is the first distinguishing feature. Secondly, the symptoms referable to the central nervous system, such as headache, irritability, vomiting, and visual changes, are absent in arthropathy. Thirdly, the marked thickening of the skin in acromegaly is also absent. Finally, the bony changes differ markedly. In acromegaly there are pronounced facial changes. The changes in the extremities present the following differences from osteopathy. The finger-ends present no clubbing, but they are square; the bones of the hands and feet are enlarged, but the enlargement is of the nature of gigantism, the bones showing general enlargement with increase in their natural ridges and irregularities, and with no deposition of periosteal new bone. These changes, moreover, do not extend above the carpal and tarsal levels.

The co-existence of a chronic primary disease, which is usually in the thorax, and of well-marked clubbing, are the chief points in clinching the diagnosis.

Prognosis.

But little need be added to what has been said on this subject when describing the symptoms and course of the disease. The prognosis as to the osteopathy is a matter of little importance to the clinician, whose attention is more urgently called to the primary disease. The patient is not as a rule troubled by his arthropathy, taking an interest in

it only in proportion to the attention paid to it by the doctor. In most cases the osteopathy gradually becomes more marked up to the time of death.

When the primary disease improves the osteopathy does not advance materially, and the clubbing sometimes disappears. Thorburn reports two instances of retrogression of osteopathy—one a case of empyema after antiseptic irrigation, the other after the drainage of a tuberculous vomica. Retrogression has also been observed in the months preceding death (Case 41). In this instance the course of the case was continuously downwards, and the improvement in the arthropathy did not influence the unfavourable prognosis. There is no evidence that resorption of the new bone ever takes place.

Treatment.

The treatment is directed almost entirely to the primary disease, as it cannot be expected that the arthropathy will improve if the primary disease is progressive. In the unusual cases in which the patient has acute joint exacerbations from time to time salicylates may be tried. In my first case the exhibition of this drug seemed to have a marked effect in shortening the attacks on more than one occasion. Local applications to the bones and joints are only exceptionally called for, and I have only seen one instance in which such treatment was indicated. The pain in the bones and joints was in this case sufficient to interfere with the patient's sleep, and relief was obtained by painting the parts with tincture of iodine.

Conclusions.

Hypertrophic pulmonary osteo-arthropathy is a chronic symmetrical disease of the bones, joints, and soft parts, affecting chiefly the distal segments of the extremities. The changes in the bones consist chiefly in the deposition of friable new bone under the periosteum, in a sclerosis of

the cancellous parts of the bones, and in the appearance of hard new bone in the diaphyses, encroaching on the medullary canal. In the joints involved an intermittent passive effusion is the most characteristic manifestation, but in certain cases the effusion is accompanied by evidence of inflammation. The joint cartilages are often the seat of erosions, and sometimes there is vacuolation also. A progressive thickening of the soft parts round the joints usually takes place, but the thickening is never very great, and it does not involve the skin. Clubbing of the fingers and toes of a special kind is nearly always present. There is no softening or suppuration in the bones or joints in osteopathy. Of the above changes those in the joints are the most evident clinically, while those in the bones are not evident in skiagraphs, and in the post-mortem room. The disease is much commoner in males than in females. Between the ages of thirty and forty is the commonest decade for osteopathy.

Osteopathy is probably always secondary to some other disease, and in the great majority of the cases the primary disease is a chronic suppuration in the thorax. It is caused occasionally by suppuration elsewhere, but in such cases some disease of the lungs is generally present. Congenital heart disease is sometimes responsible for osteopathy, and in a few instances syphilis is the only disease present. The same conditions which cause osteopathy probably lead to the clubbing also. The above causes of osteopathy probably act by producing poisonous bodies, which circulate in the blood. The theoretical considerations on which this view is based may be summarised thus:

Toxic products, whether the result of normal metabolism or of an infective process, may be divided into two varieties—volatile and non-volatile. The volatile toxins are eliminated under healthy conditions by the lungs in the expired air. The non-volatile toxins are eliminated for the most part by the cells of the liver. If for any reason the eliminating function of one of these organs is inter-

fered with, the toxins over the fate of which the lungs or the liver respectively preside will not be efficiently eliminated, and will accumulate in the blood.

This gives us an explanation of the almost constant association of pulmonary disease and osteo-arthropathy. If the liver is for any reason unable to carry on its detoxicating work, the other organs, such as the spleen (17), are capable of taking its place. If, on the other hand, anything interferes with the amount of respiratory surface available in the lungs, the volatile toxins, having no other way of escape, accumulate in the blood.

If these conclusions are correct, the presence of a toxic focus in the lungs is not essential for the production of osteopathy. What I regard as essential is the co-existence of a toxic focus somewhere in the body, with a condition of the lungs which interferes with normal respiratory interchange, *e. g.* a fibrosis, or even a chronic congestion only.

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Appendix A.

Synopsis of Cases.

This series includes fifty-five undoubted cases of pulmonary osteo-arthropathy (1—54), ten which are probably early cases of the disease (55—64), and ten doubtful and intermediate cases (65—74). I have included in the doubtful series two cases which were looked upon by Walters as undoubted cases of osteopathy.

When clubbing is referred to it is understood that it is present in a marked degree in the case of the fingers, and to an appreciable extent in the case of the toes.

By typical pulmonary osteo-arthropathy is meant involvement of the lower ends of the forearms and legs, involvement of the hands and feet, and of those parts which are usually affected as detailed in the text. When unusual bones or joints are affected, mention is made in each case.

Tubercle is entered as absent when none of the organs gave evidence of tuberculosis. In nearly all the cases in which there was any expectoration, the sputum was examined for the tubercle bacillus.

The following abbreviations are used:

O. A.	Hypertrophic pulmonary osteo-arthropathy.
C. P. T.	Chronic pulmonary tuberculosis.
C.	Clubbing.
p.-m.	Post-mortem.
Bect-s.	Bronchiectasis.
pulmy.	Pulmonary.
sympt.	Symptom.
purt.	Purulent.
famy.	Family.
jt.	Joint.
rt.	Right.
lt.	Left.
yr.	Year.
mo.	Month.

Case.	Author and date.	Age.	Sex.	Primary disease.	Interval before O. A. appeared.	Post-mortem.	Tubercle.
1	Mettenheimer, 1885	30	M.	C. P. T. (7 yrs.)	5 yrs.	—	Pre
2	Ewald, 1889	50	M.	Sarcoma of lung and caseating pneumonia	—	p.-m.	Ab
3	Waldo, 1890	54	M.	Basal tuberculosis with excavation	Simultaneously	p.-m.	Pre
4	Spillmann and Hanshalter, 1890	45	M.	C. P. T. infiltration only; enlarged bronchial glands	Appeared 1 yr. before pulmy. sympts.	—	—
5	Gourand and Marie, 1889	50	M.	Congestion rt. base; ? empyema	Before pulmy. sympts.	—	—
6	Renner, 1890	45	M.	Diarrhœa frequent for 20 yrs.	—	—	—
7	Redmond, 1890	19	F.	Pneumonia 3 yrs. before; ? empyema; diarrhœa	6 mos.	—	—
8	Bamberger, 1, 1891	23	M.	Bronchiectasis	—	p.-m.	Ab
9	Bamberger, 2	67	M.	Bronchiectasis (10 yrs.)	2 yrs.	—	Ab
10	Bamberger, 3	48	M.	Bronchiectasis (1 yr.); C. P. T.	Simultaneously with fœtidity of sputum	p.-m.	Pre
11	Bamberger, 4	25	M.	Bronchiectasis (4½ yrs.)	Simultaneously with fœtidity	—	Ab
12	Bamberger, 5	39	M.	Bronchiectasis (6 mos.)	Simultaneously with Bect-s.	p.-m.	?
13	Bamberger, 6	17	M.	Bronchiectasis (2 yrs.)	—	—	Ab
14	Bamberger, 7	30	M.	Bronchiectasis (2 yrs.)	Simultaneously with Bect-s.	—	Ab

Syphilis.	Rheumatism and gout.	O. A. and C.	Remarks.
—	—	C. typical; O. A. of left fore-arm only	Exacerbations of O. A. corresponding with the periods of deterioration of the general health.
—	—	Typical	Skin thick; thyroid absent.
—	—	Nails convex; O. A. typical, also ilia and clavicles enlarged	Rt. lobe of thyroid absent; pituitary body normal; aortic stenosis; death from bulbar paralysis.
Denied	R. pres.	Typical	O. A. apparently primary; acute rheumatism 4 yrs. before O. A. appeared; no history of diarrhœa.
—	—	Typical	Malaria.
Abs.	—	Typical; also ilia, clavicles, ribs, scapulæ, and spinous processes seemed enlarged	Skull normal.
—	—	Typical	O. A. developed to a marked extent in a few weeks; œdema dorsum of foot.
—	—	C. typical; O. A. of leg bones.	
—	—	C. of fingers; O. A. typical	Tibia sensitive; intermittent œdema of legs.
—	—	Typical	All long bones sensitive; terminal phalanges enlarged; thyroid small and colloid.
—	—	Typical.	
—	—	C. typical; O. A. fairly so	Basal meningitis; terminal phalanges of fingers enlarged; osteophytes lower femur.
—	—	C. of fingers; O. A. typical	Slight œdema of back of hand and of lower limbs; albuminuria.
—	—	C. typical	Tender diaphyses of long bones; tender sternum; slight œdema of feet; pains in rt. shoulder; diaphysial type.

Case.	Author and date.	Age.	Sex.	Primary disease.	Interval before O. A. appeared.	Post-mortem.	Tubercle.
15	Lefèbre, 1891	42	M.	Empyema (6 yrs.); puncture; drainage; Estlander; sinus	2 yrs.	—	—
16	Thérèse, 1891	38	M.	C. P. T. (11 yrs.) with excavation	10 yrs.	p.-m.	In family.
17	Ranzier, 1891	34	M.	Empyema (15 yrs.); Estlander; sinus with occasional retention	9 yrs.	p.-m.	Abs.
18	Freytag, 1891	48	M.	Bronchiectasis (1 yr.)	—	p.-m.	Abs.
19	Packard, 1892	29	M.	Empyema (13 yrs.)	7 yrs.	p.-m.	?
20	Gillett, 1892	13	M.	Emphysema and bronchial dilatation	—	—	—
21	Postmantir, 1894	21	M.	Carcinoma of parotid (5 yrs.)	2 mos.	p.-m.	Abs.
22	Chrétien, 1893	54	F.	C. P. T.; abscess in front of uterus; congenital syphilis	—	p.-m.	Pres.
23	Thorburn, 1, 1893	21	M.	Spinal caries with sinus (5 yrs.); C. P. T. with excavation apparently later	2 yrs.	p.-m.	Pres.
24	Thorburn, 2	38	M.	C. P. T. lt. upper and lower lower lobes; excavation (3 yrs.)	Synchronous with C. P. T.	—	Pres.
25	Thorburn, 3	30	M.	C. P. T. and diarrhœa (a few months)	—	—	Pres.
26	Hillier, 1894	36	M.	Empyema 2 yrs. ago; operation; no sinus	1 yr.	—	—
27	Gilbert and Fournier, 1, 1895	13	—	Diarrhœa and hypertrophic biliary cirrhosis (7 yrs.)	—	—	—
28	Gilbert and Fournier, 3	13	—	Diarrhœa and hypertrophic biliary cirrhosis (2 yrs.)	—	—	—

Syphilis.	Rheumatism and gout.	O. A. and C.	Remarks.
—	—	Typical	Œdema of feet; pigmentation; malaria; alcohol; some nervous sympts.
—	—	Typical	"Given to excesses;" erosions p. m.
—	—	Typical; inner end of clavicle also enlarged	Erosions; hands and feet always large; father had large extremities; malaria.
—	—	C. typical; O. A. of legs only.	
—	—	Typical	Dysentery for 3 mos. 5 yrs. ago, and again during the last year.
—	—	C. typical; O. A. of legs only	Albuminuria; small for age.
Abs.	R. abs.	C. of fingers and big toes; O. A. typical; clavicles enlarged also	Heart and lungs normal; malaria; thyroid and pituitary body large.
Pres.	R. ?	C. of fingers; O. A. fairly typical	Marked liability to infections; pain marked; albuminuria; arthritic attacks yielded to salicylates.
—	—	Typical	Pituitary body of cartilaginous hardness; much catarrh of intestines; waxy liver.
—	—	Typical	C. appeared 2 yrs. subsequently to O. A.
—	—	O. A. typical.	
—	—	C. of fingers; O. A. fairly typical.	
—	—	Typical in upper extremities.	
—	—	O. A. slight but apparently typical.	

Case.	Author and date.	Age.	Sex.	Primary disease.	Interval before O. A. appeared.	Post-mortem.	Tubercle.
29	Field, 1893	2	M.	Bronchitis (1 yr.)	—	—	—
30	Kerr, 1893	22	M.	Pneumonia (8 mos.); abscess of lung	7 mos.	—	Abs.
31	Demons and Binaud, 1894	35	M.	Empyema 3 yrs. ago; mucopurt. sputum since; stab wound thorax 9 yrs. ago, sinus since	10 mos. after empyema	—	Abs.
32	Springthorpe, 1895	21	M.	Pleurisy with effusion 11 yrs. ago followed by empyema and spinal caries	Several years at all events	p.-m.	—
33	Davis, 1895	4½	M.	Pneumonia 3½ yrs. ago, followed by chronic empyema and bronchitis	1 yr.	—	?
34	Thayer, 1, 1896	28	F.	Pleurisy with effusion	2½ mos.	—	Abs.
35	Thayer, 2	20	M.	Bronchiectasis	1 yr.	—	In family.
36	Thayer, 3	31	M.	Empyema 6 yrs. ago; bronchial fistula since	4 yrs.	—	Abs.
37	Thayer, 4	27	M.	Basal signs (apparently chronic empyema) (6 mos.); bronchitic patient	3 mos.	—	In family.
38	Walters, 1896	34	M.	C. P. T. (2 yrs.); spinal caries of uncertain date	10 mos. after C. P. T.	—	Pres.
39	Lockwood, 1897	10	F.	Quiescent spinal caries; no operation; crepitation rt. base; ? C. P. T.	—	—	Pres.
40	Buzzard, 1901	34	M.	Bronchiectasis; quiescent spinal caries	—	p.-m.	—
41	Author's 3rd case	36	F.	Influenza 2 yrs. ago; thoracic carcinoma	Immediately after influenza	p.-m.	Abs.
41 A	Author's 4th case	10	F.	Caries of spine (3 yrs.)	3 yrs.	p.-m.	Pres.
42	Sollier, 1889	42	M.	Empyema 2 yrs. ago; sinus since	1 yr.	—	—
43	Saundby, 1889	37	M.	Sarcoma of lung and caseating pneumonia	—	p.-m.	—
44	Author's 1st case	26	F.	Bronchiectasis (1 yr.)	7 mos.	—	Abs.

Syphilis.	Rheumatism and gout.	O. A. and C.	Remarks.
—	—	Nails incurved; O. A. typical	Face and ears large; perhaps not a genuine case.
—	—	Typical	Lordosis.
—	—	Typical; outer ends of clavicles also enlarged.	
—	G. in family.	Typical	Pituitary body normal. Adherent pericardium. Heart large and dilated.
—	—	Typical.	
—	—	Typical	Pulmonary condition cleared up; case not followed.
Abs.	Abs.	C. typical; wrists and ankles free, otherwise O. A. typical; clavicles enlarged	Slight albuminuria; diaphysial type.
Abs.	Abs.	Typical.	
Denied	R. abs.	Typical	Phlebo-sclerosis of forearm veins.
Denied	Abs.	Typical; ribs thickened	Vomica.
—	—	Typical	Diaphysial type.
—	—	Typical	Skull thick; pituitary body soft and caseous; pulmonary cavities connected with the spinal canal and the caries.
—	R. in family.	Typical; nose clubbed	Growth of hair on affected parts; muscles no R. D.; no waxy disease. (See text.)
Abs.	Abs.	Typical	Old rickets; heart and lungs normal; spinal caries; spleen and liver large; waxy disease. (See text.)
—	—	Typical	Symptoms suggestive of syringomyelia in addition.
—	—	C. of fingers; O. A. typical; ribs, clavicles, and ilia also thickened	Pain marked; slight sensory disturbances; ears and nose large; thyroid small; no further evidence of acromegaly; pituitary body normal.
No evidence; abs.	Abs.	Typical	Disappearance of C. under treatment, when the sputum became less fœtid; attacks of arthropathy in relation to the amount of sputum evacuated. (See text.)

Case.	Author and date.	Age.	Sex.	Primary disease.	Interval before O. A. appeared.	Post-mortem.	Tubercle.
45	Author's 2nd case	32	F.	Bronchiectasis (4 yrs.)	4 yrs.	—	Abs.
46	Smirnoff, 1888	23	M.	Congenital syphilis	9 yrs.	—	—
47	Gerhardt, 1890	62	M.	Acquired syphilis	—	—	—
48	Schmidt, 1892	48	F.	Acquired syphilis 23 yrs. ago	—	—	Abs.
49	Author's 5th case.	17	M.	Congenital syphilis	—	p.-m.	Pres.
50	Thorburn, 4	Boy	—	Mitral stenosis	—	p.-m.	Abs.
51	Bamberger, 8	7	—	Congenital heart disease (pulmy. stenosis); C. P. T.	—	p.-m.	Pres.
52	Bamberger, 9	53	M.	Aortic insufficiency; C. P. T.	Many yrs. after onset of C. P. T.	p.-m.	Pres.
53	Bamberger, 10	50	M.	Aortic insufficiency; fatty heart with dilatation	—	p.-m.	Pres.
54	Bamberger, 11	36	M.	Stenosis of ostium venosum; aortic insufficiency; endocarditis	—	p.-m.	Abs.
							EARLY
55	Bailly, 1862	21	M.	Purt. sputum 12 yrs.; ? empyema with bronchial fistula	1 yr.	—	—
56	Moussous, 1890	14	F	Empyema discharging sinus; C. P. T.	Synchronous with empyema	—	—
57	Chauffard, 1891	30	M.	Pleurisy 9 years ago, followed by empyema, Estlander, sinuses, and retention	4 mos.	—	—
58	Marie, 1891	51	M	Abscesses in chest wall on and off 18 yrs.; bronchiectasis (1½ yrs.)	—	—	In family.
59	Gillett, 1892	7	F	Bronchitis and pleurisy (1 yr.), followed by empyema, diarrhœa, and C. P. T.	4 mos. after bronchitis	—	—

Syphilis.	Rheumatism and gout.	O. A. and C.	Remarks.
No evidence	Abs.	C. typical; O. A. of rt. upper extremity typical	C. noticed 2 yrs. before O. A. (See text.)
Pres.	—	C. atypical; O. A. fairly typical, but malar bones were prominent	Improvement in O. A. under potassium iodide.
Pres.	—	Typical	Hair appeared on affected parts; malaria; alcohol; tremors, paresis, and muscular atrophy of limbs.
Pres.	—	Typical	Improvement under potassium iodide; no history of pulmonary disease; O. A. appeared at a time of general debility following joint pains.
—	—	C. very marked; O. A. fairly typical	Nodes on skull and left tibia; bony lesions much improved under potassium iodide; large liver; no cirrhosis or waxy disease; apical adhesion left pleura.
—	—	Typical	No. pulmy. lesion.
—	—	C. of fingers; O. A. of lower extremities	C. P. T. in early stage.
—	—	C. typical; O. A. of arms slight; otherwise typical	C. P. T. fairly advanced.
—	—	C. typical; O. A. of lower extremities only	Rt. and lt. pleura adherent at apex.
R. pres.	—	C. of fingers; O. A. of left radius only	Lungs congested only.
CASES.			
—	—	C. of fingers (parrot-beaked).	
—	—	C. of fingers (parrot-beaked)	The C. advanced and retrogressed with the pleural condition.
—	—	C. typical (parrot-beaked)	Albuminuria and diarrhœa.
—	—	C. of fingers (parrot-beaked)	Alcohol.
—	—	C. typical (parrot-beaked)	Lessening of clubbing on improvement in general health.

Case.	Author and date.	Age.	Sex.	Primary disease.	Interval before O. A. appeared.	Post-mortem.	Tubercle.
60	Moizard, 1893	5	F.	Pneumonia (1 yr.), followed by empyema	2 mos.	—	—
61	Marfan, 1893	Child		Pyelo-nephritis and cystitis following typhoid fever	—	—	—
62	Pidcock (unpublished)	55	M.	C. P. T.; history of pneumonia	—	—	—
63	Gilbert and Fournier, 2	19	M.	Diarrhœa and hypertrophic biliary cirrhosis	—	—	—
64	Taylor, 1895	12	M.	Diarrhœa and hypertrophic biliary cirrhosis	—	—	—
							DOUBTFUL AND
65	Friedreich and Erb, 1, 1888	38	M.	—	O. A. appeared 20 yrs. before pulmy. sympts.	p.-m.	?
66	Friedreich and Erb, 2, brother of the above	—	M.	—	O. A. appeared when in perfect health aged 17	—	—
67	Elliott, 1888	27	M.	Pleurisy with effusion; ? malignant disease	O. A. appeared before pulmy. sympts.	—	—
68	Fraentzel, 1888	58	M.	C. P. T. for 38 years	—	p.-m.	—
69	Möbius, 1892	51	M.	Bronchiectasis (1 yr.)	—	—	—
70	Orillard, 1892	56	M.	Abscess of lung; C. P. T.	—	p.-m.	Pres.
71	Marina, 1893	63	M.	Pneumonia 1 yr. ago	A few mos.	—	—
72	Stembo, 1893	56	M.	Pneumonia 6 yrs. ago; always subject to bronchitis	During convalescence from pneumonia	—	Abs.
73	Legrain, 1894	29	M.	Modified smallpox at 7; polyuria in attacks since 13	C. synchronous with S. P.; O. A. 2 yrs. later	—	—
74	Murray, 1895	40	M.	C. P. T. (13 yrs.)	7 yrs.	—	—

Syphilis.	Rheumatism and gout.	O. A. and C.	Remarks.
—	—	C. typical (parrot-beaked)	Improvement in C. with cure of empyema; pneumococci and a few streptococci in pus.
—	—	C. of fingers (parrot-beaked)	*Bacterium coli communis* found in urine.
—	—	C. of fingers (parrot-beaked).	
Pres.	—	C. of fingers	Congenital syphilis.
—	—	C. of fingers.	
INTERMEDIATE CASES.			
—	—	C. atypical; O. A. typical; also enlargement of sternum, clavicle, scapulæ, ilia, malar and palate bones	O. A. apparently primary; skin thick; calvarium normal; pituitary body normal; intellect normal; broncho-pneumonia; adherent pleura; emphysema; myocarditis; granular kidney; and perineuritis of peripheral nerves found p.m.
—	—	Like the above, but maxilla and spines of scapulæ were not affected.	
—	—	No C.; O. A. atypical	Multiple nodules on skin.
—	—	O. A. atypical	Large extremities from birth; large nose, maxillæ, tongue, and lips; calvarium thick; pituitary normal; thyroid atrophic.
—	—	C. typical (parrot-beaked); O. A. atypical	This was considered an undoubted case by Walters; nervous changes were present.
Abs.	—	C. of fingers and toes; knees slightly swollen	Large hands; no O. A. p.m.; perhaps we may regard this (with Walters) as an early case of O. A.
Abs.	—	C. of fingers; slight enlargement of knee-joints	Large hands; this is very possibly a case of O. A.; description inadequate.
—	—	Typical	Enlarged face and tongue; thyroid shrunken; an intermediate case.
—	—	C. typical; O. A. fairly so	Contraction of visual field; probably an intermediate case.
—	Gout present	Atypical	A very doubtful case.

ADDITIONA

Case.	Author and date.	Age.	Sex.	Primary disease.	Interval before O. A. appeared.	Post-mortem.	Tubercle.
1	Godlee, 1, 1896	19	M.	Empyema with sinus (some yrs.)	—	—	—
2	Godlee, 2	21	F.	Empyema with sinus	4 yrs.	—	—
3	Godlee, 3	29	M.	Bronchitis all his life; bronchiectasis 3 yrs.	2 yrs. after bronchiectasis	—	Abs.
4	Godlee, 4	25	M.	Pleurisy with effusion, followed by bronchiectasis or empyema	4 mos.	—	Abs.
5	O'Carroll, 1897	48	M.	Carcinoma and tuberculosis of lung	3 mos.	p.-m.	Pres
6	Hasbrouck, 1898	55	M.	Sarcoma of mediastinum and mouth	8 mos. after tumour in mouth noticed.	p.-m.	Pres

CASES.

Syphilis.	Rheumatism and gout.	O. A. and C.	Remarks.
—	—	Typical	O. A. retrogressed after successful operation for empyema.
—	—	Typical	Empyema closed two years later, and the C. retrogressed.
—	—	Typical	Lumbar kyphosis. Thyroid appeared normal.
—	Abs.	Typical. Nose ? clubbed.	Sputum a pint in the 24 hrs.
—	—	Typical	Large abscess of left lung, and left pyonephrosis found p.-m.
Denied	—	Typical. Carpal bones also involved	A man of colour. Thorax normal at first. P.-m. the tumour had spread to lungs by the bronchi. Secondary deposits in pleura, liver, and left kidney. Some tuberculous caseation in lung.

Appendix B.

Röntgen Rays and Pulmonary Osteo-arthropathy.

Skiagraphs are important in osteopathy, as they afford means of examining the condition of the bones during life. They are especially valuable when, as has been the case in several instances, no post-mortem examination is allowed. When the earlier cases were described the Röntgen rays had not been introduced. The absence of skiagraphs lessens the value of deductions drawn from these cases.

The earlier skiagraphs were taken under the assumption that the chief changes are in the joints, whereas the changes which are most marked are in the shafts of the bones. The rays do not show cartilage at all, and so the changes which take place in it do not appear in the skiagraphs.

The bone changes which are demonstrated in the skiagraphs consist in the laying down of new bone under the periosteum of certain bones; sometimes it is laid down in layers, and sometimes a fluffy appearance is seen.

The bones involved are:

Upper Extremity.

Metacarpal bones.—The new bone is laid down in the concavity of the shafts.

First phalanges.—The same, but not so much.

Second phalanges.—If present at all, slight.

Third phalanges.—No new bone.

Ulna and radius.—New bone laid down on lower end of shafts at first, sometimes in layers. Later on the whole bone may be involved.

Bones of carpus appear normal, but skiagraphs do not show cartilage (see "Post-mortem Appearances").

(*Humerus* not involved.)

Lower Extremity.

Metatarsal bones.—New bone often obvious.

First phalanges.—A little new bone in some cases only.

Distal phalanges.—No changes apparent in any case which I have examined.

Tibia and fibula.—As radius and ulna.

Tarsal bones.—As carpal bones.

Femur.—Some new bone often laid down on the anterior smooth surface of the lower end of the shaft.

The clubbing of the fingers is usually obvious in the skiagraphs. It is seen to involve the soft parts only, observers being agreed that the bones of the ungual phalanges are usually normal.

No attempt was made in the Brompton cases to examine the clavicle or ribs, the movements of respiration rendering satisfactory skiagraphy of these parts difficult.

Appendix C.

Case 5.—H. H—, a boy aged 17, the subject of congenital syphilis, was in St. George's Hospital in 1898 and 1899 under Dr. Ewart.

He was small and thin, and did not look his age. Jaundice marked. Abdomen prominent. Liver and spleen much enlarged. No ascites. Thorax normal. Nodes were present on the skull and left tibia. The knees and wrists and the tissues about them were enlarged, as well as the articular ends of the long bones adjoining. Marked clubbing of the fingers and toes.

The bone lesions improved under potassium iodide, but on readmission a year later, they had returned to their original extent. No bile in fæces.

Post-mortem.—Heart and lungs normal, except for an adhesion at right apex. Liver, scars of gummata right lobe. Stenosis of duct of left lobe. No cirrhosis. No waxy disease of organs. Bones not examined.

DISCUSSION

Dr. C. THEODORE WILLIAMS, after expressing his appreciation of the paper, said he had seen a large number of cases of bronchiectasis, but he had seen only a few cases of osteo-arthropathy among them. Why did not joint changes occur oftener in bronchiectasis if there was any causal relation between them? The rapid subsidence of the joint attacks in correspondence with the evacuation of the bronchiectatic cavities made it difficult to understand the actual formation of new bone. It was a question whether operations on the lungs in bronchiectasis would prevent the joint attacks. On the supposition that the osteo-arthropathy was due to a toxin, as stated in the paper, it was difficult to understand how the condition could be caused by congenital heart disease.

Dr. PERCY KIDD could add four cases to those referred to in the paper; three in cases of bronchiectasis and one in a case of slight pulmonary tuberculosis, but with extensive tuberculous disease of the sternum. The changes were not, he thought, so much an osteo-arthropathy, but more of the nature of an arthritis and a periarthritis. In one of his cases there was marked pain in the joint, with thickening around it and tenderness along the tibia. The explanation offered of the cause of the disease as due to defective elimination of toxins hardly seemed to satisfy the conditions, as this occurred in pulmonary tuberculosis without producing joint changes. There was evidently, he thought, something peculiar about bronchiectasis, as evidenced by the fœtor. In a case of the disease he had seen there had been no pulmonary signs during a period of two years. At the end of that time signs of a growth in the lungs appeared and rapidly increased, the patient not long afterwards dying. He could not believe that this rapidly developing malignant disease had anything to do with the arthropathy of more than two years' standing. The patient had developed hair on the face, and showed other masculine characters suggesting some alteration in the body metabolism. There was, he believed, something else behind it all. In all his cases the bronchiectasis was sacculated. Analogies with other diseases were alluded to, particularly with the acute polyarticular form of rheumatoid arthritis.

Dr. R. MAGUIRE thought that the gland action of the lung, which had been referred to in the paper, was often ignored, and it was doubtless liable to be impaired, but in explanation of these cases there was the rival micro-organismal theory to be taken into account, and the elimination of poisons by the lung was not yet established. He referred to the case of a boy, aged 16, suffering from sacculated bronchiectasis, with a cavity at the base of the lung. For two weeks before treatment with intra-

venous injections of formalin was commenced there had been an irregular pyrexia, with expectoration of a large amount of fœtid sputum, and for four days before it was commenced there was swelling in and around the joints. After four days' treatment the temperature became regular, the joint troubles disappeared, and the amount of sputum markedly diminished. This was the exact reverse of the result described in the paper, for in those cases as the amount of expectoration increased the joint affection became less. It seemed to him that the joint changes were due to a micro-organismal toxic infection.

Mr. WALTER G. SPENCER considered the toxins to cause the acute intercurrent attacks, and to affect the joints rather than the bones. In reference to the chronic cases with thickening of the bones, he thought there was no sharp line to be drawn between the pulmonary cases and other septic conditions. He believed that for these no simple toxic theory was sufficient. Venous congestion resulting from the sluggish venous circulation no doubt played a part in the thickening of bone, and this especially occurred in young patients. This would connect the condition with other surgical bone affections, also with the cases of acute periosteal swelling occurring in workers in mother-of-pearl, the dust of which led to irritation of the lungs. Acromegaly was a quite distinct disease.

Dr. NEWTON PITT agreed with the toxic theory, and suggested that one of the possible factors in the thickening of the bones might be the marrow changes associated with protective processes against infection.

Dr. RUSSELL WELLS thought, in a microbic disease affecting two parts of the body at one time, attention should be paid to a possible chemical similarity between the parts affected, on the laboratory principle of certain organisms thriving best in certain media.

Dr. SYMES THOMPSON, in reply, said that the bony changes shown by the Röntgen rays were typical of the disease, and he hoped that this means would be adopted to determine the percentage incidence of osteopathy in cases of bronchiectasis, and also to differentiate cases of this nature from osteo-arthritis and other conditions. The disease probably often escaped recognition as pain was absent in most instances. With regard to his own conclusions as to expired toxins, and the experiments of Brown Séquard and D'Arsonval, which mutually supported each other, it was only fair to say that Haldane's and Lorrain Smith's work led to quite a different view. Clubbing of the fingers might occur without venous stasis, and he believed it to be toxic.

LEFT HAND AND LOWER FOREARM. (Case 4.)

The extreme grade of clubbing is well seen. The distal phalanges are normal, the enlargement of the finger ends being confined to the soft parts.

Notice the swelling of the wrists.

The left hand has moved during the exposure, but the left ulna shows a thick layer of encasing new bone.

The right hand shows new bone laid down in the concavities of the shafts of the metacarpal bones, which is present in greatest quantity on the radial side of the first metacarpal bone. New bone also appears on both aspects of the forearm bones.

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RIGHT FOOT AND LOWER LEG. (Case 4.)

A thick sheath of new bone encases the tibia, especially on its anterior aspect where the laminated appearance points to a deposition in layers. The position of the metatarsal bones is not suited for showing the new bone satisfactorily in this situation.

There is some swelling of the ankle joint.

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ON HOUR-GLASS STOMACH

BY

B. G. A. MOYNIHAN, M.S., F.R.C.S.

Received November 3rd—Read January 25th, 1904

By hour-glass stomach ("hour-glass contraction of the stomach," "bilocular stomach," "Sanduhrmagen," "l'estomac biloculaire") is understood that condition in which the stomach is divided into two portions by a constriction at any point between the cardiac and pyloric orifices. In one rare, in fact unique case under my care, the stomach was trilocular as the result of a narrowing, due to old ulceration and cicatricial healing, at two separate points, distant about three inches from one another. In another, also unique, there were three points of narrowing, one in the body of the stomach, one at or near the pylorus, and one about one and a half inches beyond the pylorus, in the duodenum. In this case there were four sacs. As a rule the cardiac complement is larger and has thicker walls than the pyloric. It dilates and becomes hypertrophied by reason of the great obstruction met with at the scarred and narrow isthmus, which connects it with the distal portion of the stomach.

The forms of hour-glass stomach are many. As a rule the constriction is near the middle of the organ, or near the pyloric end. The isthmus may be very much indurated, or it may be tubular with very little or no indura-

tion, but with some thickening. In most instances the greater curvature seems to be pulled upwards to the lesser, but in one case I have seen the lesser tucked down to the greater.

Etiology.

Hour-glass stomach is usually described as being "congenital" and "acquired." Of these forms the congenital is said to be more frequent. Thus Fenwick in his work writes, "In about 45 per cent. of the cases which have been recorded neither ulcer nor scar could be detected in the stomach, while in the great majority of cases where an ulcer was present it was obviously of more recent formation than the stricture;" and again, "That the deformity is a rare result of ulceration is proved by the fact that only one case of the kind is mentioned in the records of the London Hospital for forty years, whereas several instances of the congenital form of the disease were encountered during the same period of time."

Meckel considered that a congenital hour-glass stomach might result from an imperfection of development, and Cruveilhier and others have suggested that the sacculation is an instance of atavism, and that there is an analogy between such a deformity and the normal bifid stomach of certain rodents and the pouched stomachs of ruminants.

On examination of specimens of hour-glass stomach there can occasionally be seen two crossing bundles of muscular fibres on each surface of the organ. These were first noticed by Mariotti, but were more fully described by Saake. The bundles are generally half an inch or more in width, and cross at the point of narrowing in the stomach. Traced from the upper side of the cardiac complement, a bundle is seen to pass to the lower side of the pyloric, and from the lower side of the cardiac complement to the upper part of the pyloric, the fibres crossing like the widely opened blades of a pair of scissors. It has been suggested that these outstanding bands of muscle by their

contraction determine the hour-glass form of the stomach, and their existence is held to be proof of the "congenital" origin of the deformity. In the only example I have seen of this muscular arrangement the hour-glass stomach was clearly the result of an ulcer, whose edges were immensely thickened and whose base had perforated. In this case the bundles of fibres followed the lines of puckering produced by the contraction of the ulcer, and were, therefore, clearly the result, and not the cause, of the deformity.

Cumston and other writers have said that in congenital hour-glass stomach the two pouches are connected by a tube or cylinder showing no scar or ulceration, and free externally from all adhesions. One such case I have dealt with by operation. I slit up the channel connecting the two sacs, and found a perfect example of "bridle" stricture, the result of healing in an ulcer which, from the mucous surface, was easily seen and felt.

An example of congenital hour-glass stomach is said to have been recorded by Sandifort; the specimen was obtained from a fœtus. This case is referred to by every writer as being a well-marked example of congenital hour-glass stomach. I have read Sandifort's description, and have seen the figure drawn from his specimen. I should certainly decline to admit that there is any warrant for considering this an hour-glass stomach; the very slight contraction seen near the middle of the stomach is nothing more than the result of a slight irregular muscular contraction. The appearance of hour-glass deformity may be mimicked with remarkable accuracy by a condition of dilatation of the stomach and of the upper part of the duodenum as the result of a congenital narrowing of the duodenum at or near the bile papilla. Such a case is recorded by Wyss.

In all the recorded examples of hour-glass stomach where a full examination of the viscus has been made, ulceration has been found. For those who believe that the deformity is congenital, the theory that the ulcer is secondary is sufficient. Thus Cumston writes, "These ulcers

are secondary, and are probably produced by the pressure of the food passing through the strictured part of the organ."

Roger Williams, in 1883, described ten examples of "congenital" contraction of the stomach. The account of one of the cases is based on the examination of a wax model; of another, on the inspection of an "inflated dried" specimen; and of a third, on the appearance of a dried stuffed specimen. It is doubtful whether one of the examples can be accepted as an hour-glass stomach. In all the others, pathological conditions, ulceration, puckering, thickening, or adhesions were found.

Hochenegg, Carrington, Maier, Saake, and many other writers who describe their examples as "congenital" mention thickening, old ulceration, adhesion to the pancreas or to the abdominal wall, localised perforation, and other conditions which are indubitably the result of chronic ulcer of the stomach. Doyen, in his work on the diseases of the stomach and duodenum, refers to a case in which at the isthmus of the stomach an adhesion to the anterior abdominal wall was found; on breaking through this a gastric fistula was exposed, showing unmistakably that an ulcer had been present, which had been prevented from perforating into the peritoneal cavity only by the anchoring of the organ to the anterior abdominal wall. This is said to be "congenital."

Mazotti relates a case of "congenital" hour-glass stomach in a woman of fifty; he believes the deformity to be due to "an unusual development of the transverse muscular fibres in a certain part of the wall of the viscus."

An examination of several specimens and an earnest search through the literature of this subject has convinced me that there is no proof whatever of the existence of an hour-glass stomach due to a congenital deformity. The absence of any observation of hour-glass stomachs in the fœtus or the young child is very striking. When those who have been describing their specimens use the word "congenital," they seem to do so without thought

or hesitation, accepting, it would appear, the mere existence of the deformity as unquestioned evidence of its congenital origin. So far as I am aware, there is not a single specimen nor an accurate record in existence which can be accepted as evidence of the congenital origin of this disease.

The causes of acquired hour-glass stomach are :

1. Perigastric adhesion.
2. Chronic ulcer.
3. Malignant disease.

1. Perigastric adhesions may arise from many causes. Most commonly they are due either to ulcer of the stomach or to gall-stone disease.

2. Chronic ulcer may cause hour-glass stomach in one of two ways. In the first there is a gradual deepening of the ulcer. As the ulcer approaches the serous coat of the stomach a few adhesions form, binding the viscus to the anterior abdominal wall, preventing the bursting of the ulcer into the general peritoneal cavity. If the ulcer be on the posterior surface a soldering to the pancreas may result, as in one case I have recently seen. When the stomach is anchored in its middle, the pouches on each side, but more especially on the cardiac side, show a tentency to sagging, and this, with the cicatricial contraction taking place in the ulcer, results in hour-glass form of the stomach. In one of my cases a malignant mass in the anterior wall had formed an extensive adhesion to the body wall. Doyen, Steffan, and Finney have recorded similar examples.

In four recorded cases (Siewers, Brown, Thomsen, Leonard Bidwell) an ulcer at the isthmus of an hour-glass stomach has perforated into the general peritoneal cavity. In the second form the chronic ulcer in its healing has caused much contraction and induration. The stomach at the point of ulceration becomes markedly puckered, and its lumen narrowed. But there is, I believe, in addition to the cicatricial contraction, another factor of chief importance in determining the narrowing of the organ. I refer

to spasm. On several occasions during the last few years, when operating for chronic ulcer, I have watched the stomach intently for several minutes, and have seen the onset, the acme, and the gradual relaxation of a spasmodic muscular contraction in its walls. Quite gradually the stomach narrows, and the wall becomes thicker and almost white in colour; when taken between the fingers the contracted area feels like a solid tumour. The spasm may be so marked as to prevent a finger being invaginated through the segment affected. The appearance presented is very striking. I have seen it in the body of the stomach and at the pylorus, but never at the fundus. As slowly as it comes on, the spasm quietly relaxes, and the stomach assumes its usual form. In one patient I watched four such spasmodic seizures at the pylorus in a few minutes, and the tumour formed by the tightly contracted muscle was so large that in a very thin subject it should have been felt on palpation of the abdomen. Such constantly recurring attacks of spasm must lead to an hypertrophy of the circular muscular fibres, and this thickening, together with the cicatricial contraction and the induration of the cavity, will amply account for the extreme narrowing of the stomach cavity with the dense thickening of the walls met with in many of the examples recorded.

The extent to which spasmodic contraction, invoked by ulceration, is responsible for the narrowing found in hour-glass stomach is not capable of being measured, but my observation of the cases I have seen during the last few years makes me ready to believe that it is not inconsiderable.

The occurrence of rings of contraction in the stomach was first observed by Sir Everard Home in 1807. He refers to an observation of Perraults, published in 1676, in which a narrowing in the middle of the stomach was observed in a lion. The condition found only on one occasion in the examination of four stomachs, two from lions, two from lionesses, is illustrated by a drawing. Sir Everard Home considered that the contractions found by him were entirely due to muscular action.

Symptoms.

The symptoms and the signs of hour-glass stomach enable a positive diagnosis to be made in the great majority of cases. In my first six cases only one was diagnosed; in my last nine, seven were diagnosed with certainty. The following are the signs:

1. If the stomach-tube be passed and the stomach washed out with a known quantity of fluid, the loss of a certain quantity will be observed when the return fluid is measured. Thus, if thirty ounces be used, only twenty-four can be made to return. Wölfler, who called attention to this sign, said that some fluid seemed to disappear "as though it had flowed through a large hole"—as, indeed, it has, in passing from the cardiac to the pyloric pouch (Wölfler's "first sign").

2. If the stomach be washed out until the fluid returns clear, a sudden rush of foul, evil-smelling fluid may occur; or if the stomach be washed clean, the tube withdrawn and passed again in a few minutes, several ounces of dirty offensive fluid may escape. The fluid has regurgitated through the connecting channel between the pyloric and cardiac pouches (Wölfler's "second sign").

3. Paradoxical dilatation. If the stomach be palpated and a succession splash obtained, the stomach-tube passed, and the stomach apparently emptied, palpation will still elicit a distinct splashing sound. This is due to the fact that only the cardiac pouch is drained; the contents of the pyloric remain undisturbed, and cause the splashing sound on palpation. For this phenomenon Jaworski has suggested the appropriate name of "paradoxical dilatation." Jaboulay has pointed out that if the cardiac loculus be filled with water, a splashing sound can still be obtained by palpation over the pyloric pouch. The sign of paradoxical dilatation is best elicited after washing out the stomach in the ordinary manner. When the abdomen is examined at the completion of the washing, and when

the stomach has been apparently drained quite dry, a splashing sound is readily obtained, for some of the fluid used has escaped into the pyloric pouch through the connecting channel.

4. Von Eiselsberg observed in one of his cases that on distending the stomach a bulging of the left side of the epigastrium was produced; after a few moments this gradually subsided, and concomitantly there was a gradual filling up and bulging of the right side.

5. Von Eiselsberg also called attention to the bubbling, forcing, "sizzling" sound which can be heard when the stethoscope is applied over the stomach after distension with CO_2. If the two halves of a seidlitz powder are separately given, and the stomach be normal or dilated, no loud sound is heard anywhere except at the pylorus; if a constriction is present in the stomach, a loud, forcible, gushing sound can be easily distinguished at a point two or three inches to the left of the middle line.

6. I first called attention, two years ago, to a sign which I have since found of great service in establishing a diagnosis of hour-glass stomach. The abdomen is carefully examined, and the stomach resonance is percussed. A seidlitz powder, in two halves, is then administered. On percussing, after about twenty or thirty seconds, an enormous increase in the resonance of the upper part of the stomach can be found, while the lower part remains unaltered. If the pyloric pouch can be felt, or seen to be clearly demarcated, the diagnosis is inevitable, for the increase in resonance must be in a distended cardiac segment. If the abdomen be watched for a few minutes the pyloric pouch may sometimes be seen gradually to fill and become prominent.

7. Schmidt-Monard and Eichhorst have both seen a distinct sulcus between the two pouches inflated with CO_2. In Case 10 in my list the two pouches, with a hard—as I thought malignant—mass between them, could readily be seen. When both pouches were distended with CO_2, alternate pressure upon them showed unmistakably that

they communicated through a very narrow orifice, for the one could be emptied slowly into the other, and the fluid could be felt to ripple gently through. The diagnosis in such a case is simplicity itself. In Case 8 a distinct notch was seen at the lower border of the inflated stomach.

8. Ewald has called attention to two signs which he considers of value in establishing a diagnosis. When the stomach is filled with water and examined by gastro-diaphany, the transillumination is seen only in the cardiac pouch; the pyloric pouch remains dark.

9. The deglutable india-rubber bag of Turck and Hemmeter is passed and distended. The bulging caused thereby is limited to the cardiac pouch, which lies to the left of the middle line.

The two aids to diagnosis of greatest value are, it will be seen, the washing out of the stomach and its inflation with gas by the administration of a seidlitz powder in two portions. The fluid used for the washing must be carefully measured before use; the tube is then passed and the stomach emptied, the contents set aside in a separate dish, and the washing commenced. All the fluid now returning is collected in a separate vessel and carefully measured. The two signs of Ewald are of little importance; a correct diagnosis can always be made without them.

Treatment.

In many cases of hour-glass stomach there is a narrowing, not only in the body of the stomach, but also at the pylorus. This illustrates the undoubted fact that gastric ulcer is often multiple. The result, so far as the treatment of the condition is concerned, is that in many of the cases no single operation will suffice to fulfill all the requirements. If gastro-enterostomy is performed from the cardiac pouch, the pyloric pouch remains undrained. Symptoms of stasis are then observed, as in a case recorded by Terrier, and a second operation is necessary.

An anastomosis from the second pouch is obviously futile. A gastroplasty which relieves the obstruction in the body of the stomach does not deal with the pyloric narrowing. In many cases it will be necessary to perform a double operation, gastro-enterostomy from both pouches, gastroplasty combined with gastro-enterostomy from the pyloric pouch, gastro-gastrostomy with gastro-enterostomy, or gastroplasty and pyloroplasty.

Thus I performed—

Gastroplasty alone in Cases 1, 2, 3, 5, 11.

Gastro-enterostomy alone in Cases 6, 7, 8, 9.

Gastroplasty and gastro-enterostomy, 12, 13.

Gastro-gastrostomy alone in Case 4.

Gastro-gastrostomy and gastro-enterostomy, 14, 15.

Hour-glass Stomach.

No.	Date.	Sex.	Age.	Symptoms and description.	Condition found; operation.	Result.	Remarks.
1	Aug., 1899	F.	39	Ten years ago the patient had an illness characterised by profound anæmia. Seven months ago there were clear symptoms of ulcer of the stomach, but neither then nor at any time any acute illness suggestive of perforation. Now, vomited after all ordinary food, and more often than not even after small quantities of fluid food. Pain after food was exceedingly severe. On examination of abdomen a dilated stomach could be felt. At one point, a little to the left of the middle line, and slightly below the ensiform cartilage, was an area 2 ins. in diameter, which was markedly tender and offered increased resistance on palpation. This area was found at the operation to correspond precisely with the area of stomach adhesion. The patient had lost weight and deteriorated seriously in general health during the last few months	Hour-glass stomach, the narrow constriction being near the middle of the stomach and adherent to the anterior abdominal wall over an area equal to a crown piece. On each side of this the stomach dilated, and seemed to be anchored by the adhesion. On separating the stomach from the abdominal wall an opening into the viscus was exposed, and the stomach contents escaped. The opening was enlarged transversely, and the wound and fistula were stitched up vertically. An omental graft was brought to cover in the sutured area in order to guard against future anchoring	Recovery	For a month after the operation there were pain at times and loss of appetite. Since then she has been free from pain and in excellent health. Appetite and digestion are good. Patient seen with Mr. Bailey, Horsforth. In February, 1902, condition was still perfectly satisfactory. In October, 1903, the patient was reported to be in perfectly good health—"in excellent condition."

No.	Date.	Sex.	Age.	Symptoms and description.	Condition found; operation.	Result.	Remarks.
2	Apl., 1900	F.	27	There was no history of gastric ulcer. The patient had complained of irregular attacks of pain in the epigastric region for 11 months, always associated with the taking of food, and coming on about 1 hour after a meal. Vomiting was occasional and irregular, in rather large quantities; there was no blood. On examination, the stomach was distended and splashy; contractions were seen when distended. Medical treatment had proved unavailing	Hour-glass stomach. The constriction was about 4 ins. from the pylorus; the passage between the two sacs equalled a No. 12 catheter in diameter. There were marked induration and puckering, but no adhesion to the abdominal wall or elsewhere. The strictured neck was divided by an incision about 2½ ins. long in the transverse direction, and stitched up vertically, the mucous membrane with a continuous catgut suture, and the serous with a continuous silk suture. Two additional interrupted sutures were applied at each end of the wound	Recovery	Vomiting for five days after the operation, blood-stained. Since then perfectly well. Patient seen with Dr. Waugh, Skipton. In March, 1903, reported to be in complete health.
3	Jan. 24th, 1901	M.	45	Ailing for 3 years. Pain in the epigastrium radiating to the left chest. Was worse after food; coming on "within half an hour," and lasting for from 2 to 4 hours, unless relieved by vomiting. Frequently vomiting about an hour after food; never any blood. Lately the pain had been almost constant, aggravated by food, and eased by vomiting. Had lost 2 st. 12 lbs. Dilated stomach. On distending with CO_2, a notch was noticed at the upper border of the stomach, and a tentative diagnosis of hour-glass stomach was made. Free HCl. A trace of lactic acid and a few rod-shaped bacilli	An hour-glass stomach. The scar of the ulcer was equal in size to a florin; was situated close to the lesser curvature, and nearer the cardiac orifice than the pyloric. There were much puckering and induration of the surface. There were no adhesions. The index finger entered, but could not pass the stricture. An incision 3½ ins. long was made transversely, and stitched longitudinally in two layers. A slender adhesion of gall-bladder to the pylorus was divided (gastroplasty, gastrolysis)	Recovery; before leaving hospital the ordinary diet without any discomfort	Weight before operation was 7 st. 6 lbs.; has gained 1 st. 8½ lbs. Patient was seen with Dr. Trevor Pritchard, Retford. In March, 1902, reported to be quite well.

4	Mar. 6th, 1901	F.	28	Symptoms of gastric ulcer for more than 5 years. Was under treatment at beginning of illness at the infirmary. Had been gradually getting worse. Vomited now after every meal; pain and vomiting came on about from half an hour to 1 hour after food. Vomit was very "sour." On examination, hour-glass stomach. On distending with CO_2, the cardiac half increased considerably, forming a very large lymphatic area. The pyloric half was distended but little; the division was clearly seen. On auscultation, a forcing, gurgling sound was distinctly heard	Hour-glass stomach. The cardiac side of constriction was much dilated, and larger than a normal stomach. Rather beyond the middle of the organ was a constriction that would just admit the forefinger; round constriction were much induration and many adhesions; especially noticeable was one thick cord-like one coming from the liver. This was divided between ligatures. The liver was slightly torn on separating wide-spread adhesions along the lesser curvature. Below it on each side the stomach sagged, and between the cavities an anastomosis was made which readily admitted three fingers (gastro-gastrostomy, gastrolysis)	Recovery	March, 1902.—Perfect result. Eats well and heartily, and has no discomfort. Patient seen with Dr. Waugh, Skipton.
5	Mar. 9th, 1901	M.	55	Stomach troubles for 16 years. At first pain after food and occasional vomiting. Five years ago an acute attack of hæmatemesis, melæna, and general swelling of the body, which it was feared might prove fatal (? perforation). No ease in the stomach since then; constant vomiting, pain after every meal, and great wasting. Now looked thin, pinched, and shrivelled. For 3 weeks had had no food, only sips of water and nutrient enemata. On examination, dilated stomach. Free HCl	Hour-glass stomach. At first it was thought to be a dilated stomach. On tracing the stomach toward the pylorus, an extremely narrowed isthmus (barely as thick as the little finger) was come to which was supposed to be narrowed pylorus, but on tracing beyond it, stomach was still found. On invaginating a finger from each side of constriction no opening could be felt. Many adhesions were separated until all was clear and free. Then incision into stomach or cardiac side of the isthmus, and a probe-director was passed through constriction, which it fitted snugly, the opening being no bigger than a No. 4 or No. 5 catheter. Gastroplasty was performed. On the pyloric side of the stricture was a column of mucous membrane forming a bridle stricture. This was ligated, divided at both ends, and removed	Recovery	The patient was in the Infirmary, under Mr. Littlewood, and was operated upon by me in his absence.

No.	Date.	Sex.	Age.	Symptoms and description.	Condition found; operation.	Result.	Remarks.
6	Apl. 6th, 1901	M.	46	Symptoms for 12 months; pain, heaviness, discomfort after meals; loss of weight and general deterioration in health. At Christmas had an attack of acute pain and hæmatemesis, and was very ill for several days; since then has never taken any food (solid or liquid) without pain. Has noticed on several occasions that the stools were "black as ink." Vomits now every day	Two ulcers near the pylorus, one on gastric, one on duodenal side. A mass equal in size to a walnut found at the pylorus. Pylorus very narrow; adherent to liver and gall-bladder by dense bands. At the middle of a hugely dilated stomach a constriction that would admit four fingers. Posterior gastro-enterostomy to pyloric pouch. At the post-mortem two ulcers (duodenal and gastric) were found, the former very adherent to the gall-bladder; the latter had perforated into a mass of adhesions, its base being partly formed by the pancreas	Death	Sent by Dr. Crawford Watson, Harrogate. All went well for three days; then a large prolapse of rectum (from which he had previously suffered) came down during the night, and was not discovered for four hours. When I saw him the prolapse was livid and œdematous, and could not be reduced until ether had been administered. From this time patient became gradually worse; the temperature ran up to 104° and 105°, and he died four days later. The following is an abstract from the post-mortem record, written by Dr. Maxwell, Telling:—"The stitches are quite sound, the opening good, and surgical technique perfect. No peritonitis. The hæmorrhoidal and inferior mesenteric veins are full of disintegrating clot (septicæmia)."
7	May 24th, 1901	M.	48	For many years has vomited after food. Pain comes on about 1½ hours after food, and is eased by vomiting. In Nov., 1899, and May, 1900, had severe hæmatemesis. Three years ago was in the infirmary, and a diagnosis of "cancer" was made. On examination, an irregular dilated stomach. On inflation, a distinct	Hour-glass stomach. The cardiac pouch much dilated, pyloric small and not dilated. The constriction was about 3 ins. from the pylorus. At the upper border of the isthmus a hard mass, equal to a walnut in size, with puckering of stomach and lesser omentum	Recovery	Sent by Dr. Isaac Taylor. Weight before operation, 8 st. 2 lbs.; weight Jan. 15th, 1903, 10 st.

				notch seen in the lower border; just above this a very loud, forcing, gushing sound heard. Hour-glass stomach diagnosed. Signs 1, 3, 5, and 6 present	(posterior gastro-enterostomy)		
8	May, 1901	F	50	Ailing many years; the symptoms dating from an illness in which "gastric ulcer" was diagnosed. A diagnosis of "hour-glass stomach" was made by Dr. McGregor Young. Signs 1, 3, and 6 present	Hour-glass stomach, the isthmus being about 2½ ins. from the pylorus. The stomach and all the intestines were thin and translucent, and seemed almost devoid of muscle. On exposing the posterior wall of the cardiac pouch, a second ulcer was seen. Posterior gastro-enterostomy was performed. After the operation, regurgitant vomiting of such severity and persistence that a second operation was undertaken, and the proximal and distal segments of the jejunal loop were united (jejuno-jejunostomy)	Recovery	Patient seen with Dr. McGregor Young. The result of the operations has been most satisfactory; the patient is much better than she has been for many years.
9	June, 1901	M.	39	Stomach troubles for 9 or 10 years. Then began quite suddenly to have great pain after food and to vomit 2 or 3 times a day; no hæmatemesis. The pain usually came on about 1½ hours after food. Seen 4 years ago by a consulting physician, who diagnosed dilated stomach, and advised lavage, which has been done ever since. Relief at first very great, but lately a serious relapse, and no relief from washing. Hour-glass stomach diagnosed. Signs 1, 2, 3, and 6 are present	Hour-glass stomach. The constriction just admitted the end of the forefinger; was situated about 3 ins. from the pylorus, at a point where loud gushing sounds were heard before operation. The cardiac complement was enormous, the pyloric a little dilated (posterior gastro-enterostomy; pyloro-diosis)	Death	Sent by Dr. Ellis, of Halifax. After the operation patient had suppression of urine; in four days secreted only 11½ oz., tinged with blood. Pulse became very rapid and of poor volume. Five pints of saline solution infused. Urine was secreted almost at once. Gradual improvement then for 9 days; then suppression for 48 hours, and death. Both kidneys diseased; the left small and granular and cirrhotic, the right granular. Operation area normal. The urine before operation had been frequently examined, and nothing abnormal discovered.

No.	Date.	Sex.	Age.	Symptoms and description.	Condition found; operation.	Result.	Remarks.
10	June, 1901	F.	25	For 3 years has suffered from vomiting, pain after food, inability to take ordinary diet. Has never vomited blood, but has seen vomit which "resembled tea." Vomiting now almost continuous. Has lost 3 st. in weight. On examination a hard mass above and to the left of the umbilicus. On distending the stomach with CO_2 a distinct swelling on each side of tumour. Hour-glass stomach clearly seen	Hour-glass stomach. A large mass 4 ins. in diameter found at the junction of the two pouches, densely hard, immovable, and adherent firmly to pancreas. Several enlarged glands. Supposed to be malignant. Stricture between the two pouches dilated freely	Recovery	Sent by Dr. Crawford Watson, Harrogate. Weight before operation, 5 st. Vomiting ceased at once, and food was freely, almost greedily taken. The tumour quickly disappeared. Looks ruddy and well. Weight now 7 st. 7 lbs. In October, 1903, reported to be over 8 st. in weight and quite well.
11	Apl., 1901	M.	40	About 6 months ago was suddenly seized with acute, intolerable pain in upper part of abdomen. Constant stomach troubles since; pain, weight, "dragging sensations." Has lost flesh quickly. On examination, a smooth globular swelling between mid-line above umbilicus and left costal margin. Soft and fluctuating	The stomach was hour-glass shaped; the constriction was adherent to the anterior abdominal wall. On separating the adhesion, the stomach was opened and gastroplasty was performed. The tumour pushed the stomach forward. The great omentum below stomach was torn through and the finger passed into the lesser sac. A smooth globular cyst found projecting into the cavity and springing from the pancreas	Recovery	Sent by Dr. J. Exley, Wortley. A pancreatic fistula remained until to-day, but is almost closed. Health and weight fully regained. In October, 1903, reported to be quite well.
12	July, 1901	F.	28	Six years' history of increasing digestion, dating from an illness described by the doctor as "ulcerated stomach." Pain comes on 1 hour after food, worse when lying on the right side. Vomits after nearly every meal. Is getting steadily thinner. Signs 1, 2, 3, 4, 5, 6, and 7 all present	Hour-glass stomach and very tight pyloric obstruction. I performed gastroplasty and posterior gastro-enterostomy into the distal pouch	Death	Sent by Dr. Baxter-Tyrie, of Keighley. Death from pneumonia on the fifth day. The anæsthetic was badly taken, lividity and rigidity of abdominal muscles being present throughout.

13	Apl. 22nd, 1902	F.	42	Chronic indigestion. The symptoms came on gradually; pain after food, vomiting and constipation. Eighteen months ago had hæmatemesis, and since then the symptoms have been greatly increased. Signs 1, 2, 3, 5, and 6 present, and a diagnosis of hour-glass stomach made	An hour-glass stomach—a perfect example. The constriction in the body admitted the little finger snugly. In the narrowed isthmus, on posterior surface a densely hard indurated area, at least ¾ in. in thickness; the lesser and greater omenta both puckered up. Gastroplasty—a scar of the ulcer seen on mucous surface of posterior part. A very tight stricture found at the pylorus; the pyloric pouch being dilated also. Posterior gastro-enterostomy from pyloric pouch	Recovery	Dr. H. H. Greenwood. A very rapid pulse for 4 days after operation. Report in October, 1903.—"Quite well, 6 months pregnant."
14	Nov. 29th, 1902	F	27	Nine years' history. Pain after food and vomiting were the symptoms first noticed. Soon all solid food caused pain and was rejected. The food became "sour," and the gas belched up smelt putrid. On several occasions blood has been vomited. The signs and symptoms of hour-glass stomach were elicited, and a confident diagnosis made. The two pouches of an hour-glass could be distinctly seen on inflation. Signs 1, 2, 3, 5, and 6 present, and an hour-glass stomach diagnosed	An hour-glass stomach was at once exposed; but following my invariable rule, I traced the stomach up to the cardiac orifice, and discovered another stricture and another pouch. There were thus two annular constrictions in stomach and three pouches. The first pouch was the largest, the pyloric the smallest, being only of the size of a lemon. Gastro - gastrostomy and gastro - enterostomy were performed. The stomach was scarred almost universally	Recovery	Dr. Knowles, Newstead, Halifax. A most excellent recovery. In October, 1903, had gained 1½ st., and was taking food well.

No.	Date.	Sex.	Age.	Symptoms and description.	Condition found; operation.	Result.	Remarks.
15	Jan. 20th, 1903	F.	34	Nine and a half years ago vomited a "great deal" of blood. Dr. Mackenzie then diagnosed ulceration of the stomach. Since then has always been ailing, especially after a moderate meal. Five years ago was very ill; had acute abdominal pain, severe vomiting, and hæmatemesis. Was in Manchester Royal Infirmary with "ulcer of the stomach." One and a half years ago hæmatemesis. For several years has taken no solid food and has never had an ordinary meal. Has lived on milk, custards, porridge. On examination, an hour-glass stomach was diagnosed. Wölfler's two signs; paradoxical dilatation; increase in subcostal tympany; gurgling sound at left end of stomach, all well marked	An hour-glass stomach and an hour-glass duodenum. Two large stomach pouches united by a narrow isthmus at the lesser curvature. Tight constriction at pylorus; the first portion of duodenum dilated to form a sac the size of a lemon; beyond this another constriction. The pyloric pouch of the stomach was more densely scarred than any stomach I have seen; its texture was almost wholly fibrous. On its posterior surface also many scars were seen. Gastro-gastrostomy and posterior gastro-enterostomy to the pyloric pouch	Recovery	Dr. Mackenzie, Burnley. Within 3 weeks of the operation ate solid food heartily, and had taken all the vegetables in season.
16	July 14th, 1903	F.	35	For the last six years has had abdominal pain, to the left side of the epigastrium chiefly, especially after food. Has vomited every week during this time; and six years ago, three years ago, and in February, 1903, had hæmatemesis. Since February has had constant pain and vomiting, is unable to take any solid or semi-solid food, and but little fluid. Is wasting rapidly, and looks thin, haggard, and very wasted	An hour-glass stomach. A deep pucker on the anterior wall and upper surface, pulling the lesser curvature down to the greater. From the centre of the dense indurated stenosing ulcer a thick band, and a web of adhesions passed up to the liver. The posterior surface of the stomach also very adherent, so that a posterior gastro-enterostomy was performed with great difficulty	Recovery	Mr. Jessop's case. Operated upon by me in his absence. Recovery most satisfactory.

Hour-glass Stomach due to Malignant Disease.

Date.	Sex.	Age.	Symptoms and description.	Condition found; operation.	Result.	Remarks.
Mar. 3rd, 1901	M.	54	Vomiting of fluid if taken in quantities exceeding an ounce (see text)	Hour-glass stomach. Narrowing close to cardia due to malignant disease which had invaded the stomach everywhere (jejunostomy).	Recovery	Patient seen with Dr. Sykes, Cleckheaton. Died April 9th.
July, 1901	F.	38	At the age of 17 had a gastric ulcer; vomiting and hæmatemesis for several weeks. Since then has always had gastric uneasiness. Ten years ago "an ulcer burst" after a long walk. She suddenly experienced acute pain in epigastrium and fainted; during the subsequent night she vomited a "chamber utensilful" of blood, and later coffee-grounds material. Since this attack has never enjoyed a hearty meal. For last few months has lost flesh rapidly; for the last three years she has been in bed, and has not been able to take anything but milk and water, and has returned most of that. Gastric tetany in limbs. Free HCl present	Hour-glass stomach, nearer the cardiac than the pyloric end. The stomach was adherent over an area about 2½ ins. in diameter to the anterior abdominal wall and liver. On detaching, the stomach was opened. The opening was about 1¼ in. in diameter, the edges over ½ in. thick, and the mucous membrane greatly thickened and pouting. At the point of adhesion the stomach was markedly narrowed. The ulcer and a surrounding mass of stomach was excised, and gastroplasty performed. Pylorus would only admit the passage of a director, and pyloroplasty was therefore performed	Death	Sent by Dr. Cheetham, Guiseley. The patient seemed to be going on well until the fourth day, when the pulse rapidly failed. The examination of the excised mass showed malignant disease to be present. The lower margin of the ulcer was greatly thickened by heaped-up granulation tissue, which, on microscopic examination, proved tobe carcinomatous.

DISCUSSION

Mr. STEPHEN PAGET asked if, in performing gastro-enterostomy, Mr. Moynihan used any form of button, bobbin, or other appliance, or simply sutured the stomach.

THE PRESIDENT remarked that the author's conclusion that congenital hour-glass stomach did not exist was a point of great importance. It would appear also that in a good many instances hour-glass stomach was overlooked. He asked in how many of the cases referred to in the paper the condition had been diagnosed before operation. It was noticeable that there was a preponderance of women over men. The mortality of 4 in 18 cases, or of 22·2 per cent., was low, and yet it was high as compared with that from simple gastro-enterostomy. The one operation of gastro-gastrostomy, it was noticeable, had a favourable issue. Gastric affections necessitating operation were far less frequent in London than in the neighbourhood in which the author's cases occurred, and he would like to ask him whether there were in his opinion any circumstances in the habits or surroundings of the working classes of the North of England which induced gastric troubles.

Dr. G. B. FERGUSON asked whether the technique was antiseptic or aseptic.

Mr. H. J. PATERSON asked where Mr. Moynihan made his exploratory incision into the stomach. As regards the mortality of operations for hour-glass stomach, Mr. Paterson thought it ought to be taken into consideration that operation possibly saved some of the patients from a future gastric ulcer or other serious gastric lesions. A case in point was quoted.

Mr. MOYNIHAN, in reply, said the greater prevalence of the disease in its surgical aspects in the north of England seemed without explanation. The diet peculiar to the north which might possibly have a causal relation was the extensive use of stewed tea and dry bread. In the cases of duodenal ulcer, beer-drinking on an empty stomach seemed to be very general. The mortality was higher than it ought to be, partly because the patient was reduced by years of gastric disorder, both from the ulcer and from the impossibility of cleansing the distal pouch. No appliance of any kind was used by him for any abdominal anastomosis. The operations were purely aseptic; under no circumstances were any antiseptics allowed in the peritoneal cavity. As far as his experience went, perforation always occurred in the isthmus of an hour-glass stomach. This was, he believed, a much more common condition than surgeons were prepared to admit; and this depended, he thought, on a lack of a careful examination of the whole of the stomach before operation. Gastric ulcer was much more often multiple than single.

OBSERVATIONS

ON

METABOLISM IN THE FEBRILE STATE IN MAN[1]

BY

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(COMMUNICATED BY DR. G. NEWTON PITT.)

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[1] This paper was presented as a thesis for the M.D. degree at Cambridge in May, 1903.

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in the urine—The cause of retention of water —The excretion of sodium chloride—The relation of sodium to chlorine—The cause of the retention of chlorine and of sodium—Treatment of fever with salts of sodium—Chlor-metabolism in malaria.

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Analytical methods and tables of results.

NOTE.—For the convenience of those interested in one section only of the subject the literature of each is given separately, even when it involves repetition of references.

Part I.—Introduction.

Of the work done hitherto on the above topic the greater part has been carried out on cases of typhoid, typhus, relapsing, and intermittent fevers, or of pneumonia, which has been for some reason a special favourite. Of these diseases the last, owing to the dyspnœa, to the profuse sweating which may accompany the crisis, and above all to the pulmonary exudate, is scarcely suited for the study of pure febrile metabolism, and conclusions drawn from observations upon it should be applied with much caution in considering other fevers. Typhoid, again, if diarrhœa be present, must yield unsatisfactory results; and its long duration is another disadvantage; moreover both typhoid and typhus are apt to be accompanied by such mental disturbance as to render investigation impossible. Lastly, malaria differs so much from other fevers, both in its nature and effects, that it must be considered apart; moreover here, as in pneumonia, and also typhus and relapsing fever, critical sweats introduce a serious complication. Therefore, in spite of the very large amount of work already done, there seems room for further observations on pure bacterial fevers unaccompanied by any of the above drawbacks. Accordingly during seven years' residence at the London Fever Hospital I have collected a considerable number of picked cases, comprising scarlet fever, morbilli, rubeola, and diphtheria, and have studied the urine with the results which form the basis of this paper.

Methods of investigation employed.—The patients selected were with very few exceptions young male adults suffering from uncomplicated attacks, and whose temperature before or at the time of the commencement of the analysis was

high, but who were not so ill as to render collection of the urine difficult. Precautions were taken to prevent loss during defæcation, and young children and females were avoided. The urine was collected from 7 a.m. to 7 a.m., and reckoned to belong to the earlier day. It was nearly always made up to some convenient bulk, such as 1000 or 1500 c.c. before analysis. A description of the analytical processes used will be found under each heading, or in the appendix. Nearly all the patients were during the fever on a diet of three pints of milk and one egg, so that the ingesta at this period can be calculated fairly accurately. No beef tea was used. When solid food was added the intake became variable. Water was allowed as desired. The temperature recorded is the highest evening temperature unless otherwise stated, and is therefore taken about the middle of the twenty-four-hourly period.

A few of the cases were under the care of Dr. Hunter or Dr. Box, to whom I am indebted for permission to include them; the great majority were, however, Dr. Washbourn's. The latter took much interest in my work, and I deeply regret that he is no longer alive to witness its completion, nor to receive the thanks which his helpful kindness to myself during many years would have rendered me particularly desirous to record in this place.

To Dr. Box, who has kindly supplied heart muscle from St. Thomas's Hospital, to Dr. Cuff, who has done so from the North-Eastern Fever Hospital, to Dr. Stewart, from the South-Western Fever Hospital, and to Dr. Hutchison, from the London Hospital, I tender my best thanks. The last, in particular, has afforded much help and encouragement, and his own work on chlorine metabolism has proved a mine of information to me.

Effects of the diet of fever in absence of pyrexia.—Before considering the results of fever it is essential to form some idea of the effect, on a normal individual kept in bed, of the diet above mentioned—namely, three pints of milk and one egg. For this purpose I have conducted

two series of analyses: the first on the urine of a large healthy policeman; the second on that of a youth, convalescent from scarlet fever, who, on account of some albuminuria, returned to bed and to the above diet. The age and size of these two represent about the maximum and minimum of the cases in my series, so that the mean of the two should give a fair idea of what the excretions of these would have been on an average, had they also had no fever, but merely been kept in bed and taken the diet in question. The results express grams in twenty-four hours, acidity being given in terms of oxalic acid. Water is measured in c.c.

No. 1.—J. R—, aged 36. Healthy policeman, just over six feet high, and weighing thirteen stone. He was taking ordinary food and getting up daily until the commencement of the experiment, but had been doing no work. He had, in fact, been certified to have scarlet fever. He was now kept in bed for three days, and took only the diet of three pints of milk and one egg. The analyses include only the second and third twenty-four-hour periods.

			N.					
	H_2O	Acid.	Total.	+ U.	NH_3	Ext.	+ U.	− U.
2nd.	1349	2·28	13·07	11·79	·67	·61	25·26	·49
3rd.	881	2·28	14·29	12·19	·57	1·53	26·12	·59

Analyses continued.

							P_2O_5.		
NH_3.	K_2O.	Na_2O.	MgO.	CaO.	SO_3.	Cl.	Total.	Ac.	Neut.
·81	1·61	2·26	—	·33	1·79	3·70	2·74	1·44	1·30
·69	1·57	1·54	·11	·39	1·20	1·65	2·95	1·49	1·46

No. 2.—W. R—, aged 17. Rather spare and small for his age. The analyses include three days in bed and on the above diet.

				N.			
	H_2O.	Acid.	Total.	$\overset{+}{U}$.	NH_3	Ext.
1st . .	1670	2·06	11·33	10·41	·38	·54
2nd . .	995	1·44	7·84	7·35	·19	·30
3rd . .	1015	1·83	9·32	8·77	·25	·30
Av. of 2nd and 3rd days	1050	1·63	8·58	8·06	·22	·30

Analyses continued.

$\overset{+}{U}$.	$\overset{-}{U}$.	NH_3.	K_2O.	Na_2O.	SO_3.	Cl.	P_2O_5.	Alb.
22·31	·47	·46	—	—	1·86	4·04	2·21	·8
15·75	·30	·23	1·76	2·01	1·27	1·91	1·85	·6
18·79	·33	·30	—	—	1·50	1·70	2·09	·3
17·27	·31	·26	1·76	2·01	1·38	1·80	1·97	—

If we take the last day of No. 1 and the average of the second and third days of No. 2, who more quickly obtained what was probably his normal for the diet, and strike a mean between these two sets of figures, we arrive at results as follows, which will hereafter be taken as the mean normal excretion for the diet, without fever.

		N.					
H_2O.	Acid.	Total.	$\overset{+}{U}$.	NH_3.	Ext.	$\overset{+}{U}$.	$\overset{-}{U}$.
965	1·95	11·43	10·12	·40	·91	21·69	·45

Analyses continued.

NH_3.	K_2O.	Na_2O.	SO_3.	Cl.	P_2O_5.
·47	1·66	1·77	1·29	1·72	2·46

Percentages.

$\overset{+}{U}$.N. = 88·5 %, NH_3.N = 3·5 %, Ext.N. = 8 %, and $\overset{-}{U}$.N. = 1·3 % of the total N

Ratios.

$$\frac{\overset{+}{U}}{\overset{-}{U}} = 48{\cdot}2. \qquad \frac{\overset{+}{U}}{P_2O_5} = 8{\cdot}8. \qquad \frac{\overset{+}{U}}{SO_3} = 16{\cdot}8. \qquad \frac{\overset{+}{U}}{K_2O} = 13{\cdot}0.$$

In urine of a normal man on mixed diet these ratios are about $\frac{\overset{+}{U}}{\overset{-}{U}} = 38.$ $\frac{\overset{+}{U}}{P_2O_5} = 10.$ $\frac{\overset{+}{U}}{SO_3} = 13.$ $\frac{\overset{+}{U}}{K_2O} = 10.$

The effect of fever diet on these ratios is therefore to raise the figures for $\frac{\overset{+}{U}}{\overset{-}{U}}$ $\frac{\overset{+}{U}}{K_2O}$, and particularly $\frac{\overset{+}{U}}{SO_3}$, but

to lower that for $\frac{+}{P_2O_5}$, or, in other words, to a cause relatively large excretion of phosphoric acid and relatively small excretion of the other bodies, especially of sulphuric acid. I have calculated the value of the diet, partly from analyses and partly from tables, as 9·98 grs. of nitrogen, 1·79 of chlorine, 1·21 of Na_2O, 3·18 of K_2O, and 3·18 of P_2O_5. On the average there is therefore a distinct loss of nitrogen from the body on this diet, as, indeed, is to be expected. The excretion of sodium, chlorine, and phosphoric acid represents probably equilibrium when loss by fæces is remembered, while potassium is excreted in unduly small amount. Nevertheless this amount is very much larger than that given by Salkowski for the excretion of potash on a diet of fever without pyrexia.

It will be noticed, on comparing No. 1 with No. 2, that the former, who lost nitrogen, excreted a relatively large amount of ammonia and extractives.

Part II.—The Metabolism of the Body Fluids, and of the Salts specially Characteristic of them.

On the Excretion of Water, and the Condition of the Body generally as regards the Fluids contained in it.

Physiological variations in the output of water.—1. *By the kidneys.*—In health the daily excretion of water was given by Parkes (1), as an average result of many and divers observations by different authors, as 1500 c.c. for an adult man. Hildersheim (2) calculated the loss as 1583 grams for a man of 50 to 60 kilos. weight. Yvon and Berlioz (3) gave a somewhat lower figure, 1360 c.c. for males and 1100 for females. Undoubtedly wide variations may be within physiological limits.

2. *By other means.*—The loss of water by the fæces was estimated by Hildersheim at 117 grams, by the skin at 791, and by the lungs at 410 grams; the loss of carbon by the lungs at 227 grams. On the other hand, much larger estimates have

been given for the loss by the skin, for Schierbeck (4) has calculated that two or three litres of water may be excreted daily by this route even under normal conditions. Sanctorius (5), writing in the year 1614, estimated the insensible loss of weight as five eighths of the total output from the body. His investigations covered many years. Leyden (6), by a system of repeated weighings of the body and of the ingesta and egesta, calculated that the insensible loss of a man at rest in bed is ·073 per cent. per hour. A man of 65 kilos. would therefore, if we allow 230 grams for loss of solids, *i. e.* of carbon and small quantities of salts by the lungs and skin, excrete about 900 c.c. of water daily by these routes in absence of fever.

The effects of fever on the output of water.—1. *By the kidneys.*—The normal excretion of health and on a full diet is not usually attained in fever, and, inasmuch as the output of solids is not similarly reduced, the specific gravity and percentage acidity are wont to be high, the former frequently attaining 1030. Nevertheless great variations occur in the quantity passed. Thus in relapsing fever, at any rate in the relapse if not in the primary attack, the quantity of urine is frequently in excess of the normal, as has been shown by Wyss and Bock (7), Unruh (8), Murchison (9), and others. Now the relapse, though shorter, is commonly attended by an even higher temperature than the primary fever, and one seldom approached without fatal result in other febrile conditions, 107° F. being not uncommonly attained and not rarely exceeded. Diminished excretion of urine is therefore not an essential accompaniment of even high fever; and Parkes (10), who was one of the earliest to maintain that retention of water occurred in fever, had to admit that diminution of urinary water was less constant than abnormal body heat. Large excretions of urine during fever are, in fact, not uncommon in the literature, and have been recorded by A. Vogel (11) in typhoid, by Fraenkel (12) and others in pneumonia, by Cario (13) in various fevers, and by Ringer (14) in scarlet fever. Sahli (15) has, moreover, demonstrated that copious excretion

can be induced, in spite of fever, by subcutaneous saline infusions; and Valentini (16) has shown that the same may be brought about by merely increasing the intake by the mouth. By this means he raised the daily quantity of urine from 500—600 c.c. to 3500, and by adding sugar in addition, to 5000 and even 6000 c.c. Again, diuresis is a constant accompaniment of the febrile movement in malaria, as was first demonstrated by Traube and Jochmann (17), and later in this country by Ringer (18). Further, Naunyn (19) found that, when fever was induced in a fasting dog by the injection of muscle extract, the urine rose from 180 to 280 c.c. without any change in the intake of water; and Senator (20) obtained similar results in dogs in which fever was produced by the injection of pus. Von Noorden (21) states that diuresis is a constant early effect of a rise of temperature, and due to the congested condition of the internal organs, an opinion expressed also by Liebermeister (22), while Haig (23) goes yet further, and holds that any subsequent diminution in the urine is the direct result of this early excessive loss. On the other hand, Parkes (10) stated with regard to this matter, "Professor Vogel has lately directed particular attention to it, and found diminution to occur at the very commencement of pyrexia, an observation which I can confirm." However, Haig mentions a case where, as the result of the onset of an attack of measles in the course of subacute nephritis, the diuresis which occurred completely removed the anasarca which pre-existed. Again, Kalinin (24) quotes two cases, one of cirrhosis of the liver and one of albuminuria, who contracted typhus and relapsing fever respectively, and during the incubation period lost large quantities of water by the urine. The same author finds that, when fever is experimentally produced in animals, the largest loss of weight and the largest excretion of water occur in the period of incubation when the output of nitrogen is small. It would seem, therefore, that loss of water quite sufficient to account for some

subsequent diminution in the urinary excretion may occur if not with the onset of fever, at any rate earlier.

Author's results.—My own tables show considerable variations, as must be expected, especially as the quantity of water was not constant. I therefore give them chiefly because I wish hereafter to demonstrate the relation of the excretion of water to that of urinary solids. For this purpose I have collected a number of figures representing the twenty-four-hour excretions of patients all on the same diet—namely, three pints of milk and one egg, and who were not influenced by diuretics, and grouped them as follows. The figures represent c.c. in twenty-four hours:

	Number of samples.	Maximum.	Minimum.	Average.
1. With temperature of 103° and over	24	1688	534	890
2. „ „ 102°—103°	8	1250	480	811
3. „ „ 101°—102°	14	1685	428	1080
4. „ „ 100°—101°	10	1780	412	1098
5. „ „ 99°—100°	8	1258	625	922
6. „ „ under 99°	11	1160	360	664
For all with temperature of 100° or over	56	1688	412	958
„ „ below 100°	19	1258	360	773

If we now collect figures showing the excretion on the first return to a normal diet, twenty-two samples yield a maximum of 2105, minimum 491, and average 1171. There is nothing in these figures to demonstrate any retention of water during the fever; on the contrary, the small excretion with the fall of temperature suggests that the body was rather poor in water than otherwise. This matter can only be decided by reference to loss of water in other ways.

2. *Loss of water by other means.*—The loss of water by the fæces in fever is probably, in absence of diarrhœa, less than in health; indeed, this has been demonstrated by Terray (25) to be the case.

The insensible loss of weight in fever has been carefully studied by Leyden (6). His figures, giving an average for various fevers, are, during high fever, ·1 per cent. per hour, with remittance ·12 per cent.; at the crisis ·155 per

cent., and in the epicrisis, that is during the next day or two, ·085 per cent. If we translate these figures as before, but allow, instead of 230, 350 grams daily for loss of solids by the skin and lungs during the fever and crisis, they will yet represent, for a man of 65 kilos. weight, a loss of 1210 c.c. of water daily during high fever, 1522 c.c. with remittance of it, 2068 c.c. during the crisis, and in the epicrisis, where I allow but 230 grams for solids lost, 1096 c.c. In malaria the loss during the sweating stage was found to be no less than ·54 per cent., or about 336 c.c. of water, per hour.

These results of Leyden are quite in keeping with those of Weyrich (26), who found that an acceleration of the pulse increased the excretion of water by the skin by, on an average, about 1 per cent. per beat added. Also with those of Schierbeck (4), showing that by raising the temperature of the surrounding air from 29·8° to 38·4° this loss was increased from 532·8 to 3811·2 c.c. in twenty-four hours. Again, with those of Leyden (27) himself, who demonstrated that the volume of the expired air was increased in fever in the proportion of 1 : 1½ or 1¾. When it is borne in mind that this air is saturated with water at the temperature of the febrile body, it is evident that the loss by this means must be very great, and particularly in pneumonia, where the respirations may be raised to 50 per minute. In fact, the general conclusion I arrive at is that the figures given above for the insensible loss are probably rather an under- than over-estimate, especially for cases of pneumonia. Leyden gives special figures for pneumonia, which I shall have occasion to quote presently. It is not likely, however, that he chose cases with exceptionally rapid respiration, who were seriously ill.

The general effect of fever on the condition of the body in regard to its fluids.—This is a matter about which there has been and remains much difference of opinion. Of the older writers, Parkes and Murchison held that there was or might be retention of water; and among modern writers Terray (25) and von Moraczewski (28) may be quoted in

support of this view. On the other hand, Buchanan (29) repudiated the idea of water retention; Liebermeister (22) held that it only occurred if the fever were of long duration; while Senator (20) considered that the loss of weight in fever was largely due to the loss of water, and few have given more study to febrile metabolism than he. Of recent writers, von Noorden (21) considers that the body contains less water in fever; and Sahli (15) and Valentini (16) actually attribute the beneficial effects of saline injections and copious libations, not so much to the washing out of deleterious matter, as to the remedying of this poverty of the tissues in water during the febrile state. These writers attribute the diminished urinary excretion to diminished intake and increased loss by other routes. This was also the opinion of Cohnheim (30), whose views on such a matter cannot be lightly rejected. Finally we have the evidence of Riva-Rocci and Cavallero (31), the only authors who have, so far as I am aware, attempted definitely to decide this question. They studied daily a case of typhoid with high fever. The period of investigation covered the second, third, and fourth weeks, during the first two of which the temperature rose regularly every day to near or over 40°, while during the last it fell gradually without quite reaching the normal level. The patient was every morning at the same hour carefully weighed, and all the intake by the mouth and output by the urine and fæces for the day were weighed also. As a control, the volume of the expired air, the quantity of oxygen taken up, and of carbonic acid lost were also estimated. The water in the food, in the urine and the fæces was calculated, and finally that given up by the katabolism of the tissues themselves was arrived at by estimation of the excreted nitrogen. The result of this most comprehensive research was to show that during the first week of the experiment but 67 c.c. of the 875 c.c. of water released from the tissues was retained, the rest and all the intake being lost. During the next week there was no retention, all the 828 c.c. from the tissues being

excreted; while in the last week, when the temperature was merely falling gradually, there was an absolute loss of 1100 c.c. of water from the body beyond that taken in and set free by metabolism, in spite of the fact that the patient was taking less fluid then than at any previous period. This loss indicated to the authors that during the first week of fever more water was retained than during the second, and they conclude that early in fever some retention occurs, this retention being intimately connected with the pyrogenetic process, and not due to any mechanical cause; but that the body soon attains a new water equilibrium, which is then maintained until the temperature falls. I would add that the loss of 1100 c.c. of water during the fourth week is no proof that as much as this had been stored up, though it makes it probable that more than 67 c.c. were retained during the first week of fever; it is, indeed, not unlikely that, as is common when sudden changes occur, too much water was then excreted, so that with the attainment of a normal temperature the tissues became somewhat unusually dry. No evidence in any way comparable to the above has, so far as I can ascertain, been produced by the extreme advocates of the water-retention hypothesis.

Again, it is acknowledged by von Moraczewski, the most vigorous supporter of this hypothesis, that the blood in fever is not more watery than it is in health. My own study of the literature of this subject leads me to conclude that while it may be rather more watery, this condition is not constant, and the contrary may occur; further, that increased percentage of water where it occurs is due rather to the loss of albumen than to increase of the fluid component, and is characteristic of prolonged rather than acute fever; also that this watery condition does not approach that found in anæmia. For analyses bearing on this point I must refer readers to the works of Becquerel and Rodier (32), F. Simon (33), Jarisch (34), Reinert (35), Stein (36), von Limbeck (37), and Ritter von Stejskal (38). Von Noorden considers that the blood

becomes more watery only at the end of a fever, the lost water being restored more quickly than the lost solids. The condition of the blood in fever, therefore, furnishes evidence that the tissues also contain but little more water than they do in health, while the diminished urinary excretion which can so readily be increased by augmenting the intake, and is therefore not due to renal inadequacy, points strongly in the same direction. It remains to consider the arguments of the supporters of the above theory. They are based mainly on three foundations, namely, the results of—

1. Examination of the tissues after death from fever.
2. Observations by Leyden on the loss of weight therein.
3. Comparisons of the intake and output, in which the insensible loss is merely guessed at.

1. *Examination of tissues.*—Von Moraczewski has published a number of analyses of various organs after death from pneumonia and conditions associated with anæmia, and finds in almost all of them a large excess of water, so that the dry matter is nearly always under 20 per cent., and commonly very much under. His figures show very considerable variations; *e. g.* in pneumonia the liver of one case contained 34·1 per cent., another 11·7 per cent. of dry matter, the kidney 9·4 and 12·2 per cent., the lung 12·4 and 9·9 per cent. Whereas Beale (39) found 18·3 per cent. in the lung in pneumonia, and but 16·7 per cent. in health. Further, in a case of death from hæmorrhage but 4·3 per cent. of dry substance was found by von Moraczewski in the spleen, and in a case of carcinoma but 8·8 per cent. in the muscle of the heart. These figures throw doubt upon the value of his methods, and, indeed, he seems to have made no effort to remove from his samples their superfluous blood. This neglect would lead to a larger error in cases of fever than under normal conditions, owing to the congested conditions of the organs, and it is therefore unfortunate that he supplies no analyses of normal tissues by his own method, nor of febrile tissues by any other. His figures for the

former are taken from the literature, and the authors quoted used different methods. Also the muscle he used was heart muscle, which I find to contain normally excess of water.

Now Hutchison (40) supplies analyses of tissues after fever, and he was careful to remove the blood as far as possible. His figures show but a trifling excess of water over the normal in the febrile organs, and he is not himself disposed to consider it sufficient to allow of any conclusion to be drawn. I cannot, therefore, accept von Moraczewski's results without further evidence to confirm them, especially as Samuel (41) mentions a peculiar dark red and *dry* appearance as being characteristic of the muscles after death in fever. I have not myself noticed as a rule any wateriness of such tissues except in the case of the spleen; further, in a series of analyses which I shall have to discuss more fully when dealing with chlorine retention I have obtained the following results.

Author's results.—I have chosen heart muscle almost exclusively, partly because muscle is the tissue chiefly concerned in metabolism, partly because this particular muscle is readily procurable and does not quickly decompose, and partly because, owing to its intimate relation to the blood, it should be specially affected if the problem of water retention were a purely physical one. The tissue has been thoroughly minced, squeezed free of blood as far as possible by wringing out small quantities at a time in muslin, and then dried *in vacuo* over sulphuric acid without heating. While this method is very tedious, it seems to me to be less open to objection than any other.

	Per cent. of water.		Per cent. of dry matter.
1. Normal heart muscle of bullock . .	76·90	...	23·10
2. Normal heart muscle of man aged forty-five, killed as the result of railway accident; death within three hours . .	78·92	...	21·08
3. Normal heart muscle of child aged four, killed by accident	78·91	...	21·09

	Per cent. of water.		Per cent. of dry matter.
4. Normal heart muscle of man aged seventy-two, run over by an omnibus . . .	76·11	...	23·89
5. Febrile heart muscle, adult; acute rheumatism	80·53	...	19·47
6. Febrile heart muscle of adult; typhoid with septic complications . . .	80·07	...	19·93
7. Febrile heart muscle of adult; pneumonia and pericarditis	80·22	...	19·78
8. Febrile heart muscle of child aged four; acute toxic scarlet fever	78·72	...	21·28
9. Febrile heart muscle of adult; pneumonia uncomplicated	78·44	...	21·56
10. Liver of No. 9	75·69	...	24·31

Normal skeletal muscle of bullock (rumpsteak) was found to contain 72·61 per cent. of water and 27·39 per cent. of dry matter, while normal skeletal muscle of man is said to contain 72—74 per cent. of water.

It appears from the above results that normal heart muscle, whether of man or ox, contains more water than normal skeletal muscle, but that febrile heart muscle contains but little more water than normal heart muscle; this small excess being probably due simply to the fact that the patient died slowly. In fact, if a febrile patient were killed by accident, no more water than normal might be found in his muscle,—indeed, perhaps less, for the acutest fevers yielded the hearts containing least water. Further, no such great variations occur in my results as appear in those of von Moraczewski.

2. *Leyden's observations.*—Leyden found the daily loss of weight in fever to average as follows:—With high fever ·572 per cent., with remittance ·450 per cent.; at the time of the crisis 1·06 per cent., in the epicrisis ·59 per cent., and in early convalescence ·24 per cent. He drew the conclusion that the great loss of weight at the time of the crisis was due to the elimination of superfluous water retained during the fever, and that this elimination continued for a time after. He argued that consumption of tissue would not continue so late, and if the loss were not

due to the cause assigned, it would be made good sooner. He further supported his argument by reference to changes in the appearance of the patient after the crisis. Even if we accept Leyden's argument entirely—and it is not free from objection, as I will presently show—all it demonstrates is that the loss of water in fever does not keep pace with the loss of solids; and, indeed, he may not have intended to prove more, for he speaks of a similar retention of nitrogen as being probable, and he appears to be rather combating the view that the cause of the thirst in fever is an abnormal dryness of the tissues, than desiring to demonstrate that these tissues are very seriously wet. I have not, therefore, included him among the extreme advocates of the theory of retention. Let us, however, for a moment assume with Terray, von Moraczewski, and others that there is absolute retention of water, or rather that there is no loss, that water equilibrium is maintained; we must then conclude that the ·572 per cent. of body-weight lost in high fever consists exclusively of dry material. Hence a man of 65 kilos. weight would lose in but a week of such fever, a period often exceeded twofold, about 2500 grams of dry matter, equivalent to some 10 kilos. of living tissue. Such a destruction is very rare in actual experience. Further, he would have retained in his system about 7 litres of extra water, a quantity equal to one and a half times the original volume of his blood. The elimination of such a store at and shortly after the crisis would cause a remarkable loss of weight indeed, and far in excess of that actually observed by Leyden. The conclusion to be drawn from Leyden's figures seems, therefore, to be exactly the opposite to that drawn by Terray who refers to them, namely, that the loss of weight in fever is largely, indeed principally, due to loss of water. Nevertheless the figure given by Leyden for loss of weight in the acute stage is insignificant when compared with that given by Wachsmuth (42) for the same during the early days of pneumonia, when but little food was taken, namely, 1·62 per cent. daily. Translated as

before, the loss of tissue in a week would be about 28 kilos., and the water retained about 2½ litres. To return to Leyden's argument, it must be remembered that the time of and shortly after the crisis is the time when the loss of solids is wont to be excessive, and one would not expect this deficit to be made good immediately. Again, it is not improbable that an abnormal katabolism of tissue does continue for a time after the crisis, for the insensible loss remains high, suggesting abnormal production of heat, while the post-critical excretion of nitrogen has been attributed to this very cause. Lastly, inasmuch as the increased loss of water at the time of the crisis takes place in general through the skin, which is much more concerned with the regulation of the body temperature than with that of its fluids, it is legitimate to suppose that much of the increased and continued loss is due rather to an active and successful effort to reduce the temperature, and thereafter to keep it down in spite of continued abnormal heat production, than to any desire on the part of the organism to rid itself of superfluous fluid accumulated previously. Circumstances favouring this conclusion are the considerable increase in the insensible loss with mere remittance of fever, the small excretion of urine which often accompanies the crisis, and the particularly profuse sweating which attends the latter in malaria, a fever of short duration and accompanied by diuresis, but where the temperature falls rapidly.

3. *Comparison of the intake and output.*—The most accurate work on these lines is that of Terray (25). The intake by the mouth and output by the urine and fæces were measured with the utmost care, so that no room was left for error except in the estimation of the insensible loss.

I give below the figures showing the results in a case of pneumonia:

Loss.					Intake.			
			By skin and lungs.					
Temp. 40·4°,	urine	1450 c.c.,	fæces	830 c.c.	3950 c.c.,	medicine		
„ 40·6°,	„	1940 c.c.	„	„	3550 c.c.	„		
„ 40·5°,	„	2380 c.c.	„	400 c.c. „	3600 c.c.	„	640 c.c.	
„ 40·9°,	„	2420 c.c.	„	„	2450 c.c.	„		
Crisis,	„	1400 c.c.	„	„	2220 c.c.	„		

Total intake of water 16,290 c.c.; output, 14,014 c.c.; "retention" 2150 c.c.

He thus calculates that the patient during but five days of fever, which, moreover, be it specially noted, included the crisis, held back no less than 2150 c.c. of the water which he took, not to mention that which he must have released from his tissues. Nevertheless further figures show that *he lost none, but continued to add to this store at the average rate of* 98·8 *c.c. per day during convalescence.*

Let us now turn to Leyden's figures showing the insensible loss in pneumonia, figures which I think are probably an under-estimate for a case like this of Terray's, who was taking such large quantities of fluid; they are as follows:—With high fever ·106 per cent. per hour; with remittance ·119 per cent.; and at the time of the crisis ·162 per cent. Translated into water as before, they become for a man of 65 kilos. 1303, 1506, and 2177 c.c. respectively per day. Nevertheless Terray takes 830 c.c. as the daily unalterable insensible loss throughout the entire episode, including the day of the crisis. The conclusion I draw from Terray's figures is that his patient lost all through the fever more water than he took, and at the time of the crisis a great deal more; but that during convalescence, as he regained weight, some of this loss was made good, *and that then for the first time an absolute retention of water occurred.* I venture to think that this is not only a legitimate deduction, but on the face of it a far more probable one than that of Terray. I have quoted Terray's figures because his work is the most careful on this subject.

A large number of others are given by von Moraczewski (28, *c*) showing the "balance" between intake and output of water in pneumonia, but he did not take the same precautions as Terray to insure accuracy, for the water of the fæces was not estimated, nor was the intake carefully measured. The largest "balances," 2400 and 2300 c.c. respectively, occurred in two fatal cases. None of the figures are in excess of what might be lost by lungs, skin, and fæces in cases of pneumonia with high temperature and much accelerated pulse and respiration, who were at the same time taking as a rule large quantities, about 3000 c.c. daily, of fluid. Hence von Moraczewski's figures do not upset the conclusion arrived at by the study of Terray's. At the same time it remains not improbable that the loss of water in fever is not in proportion to that of solids, and that the tissues, if not the blood, are in consequence slightly more watery than in health, unless diarrhœa is added to other causes of loss. Further, it has been shown by Parkes that in rare cases of fever there may be absolute retention of nitrogen, and again by Murchison and many others that urea may accumulate in the blood in considerable quantities in the typhoid state of typhus. Under these circumstances it is conceivable that an absolute retention of water might also occur. They are, however, conditions which are now rare, and are associated with grave cerebral symptoms. The supposition that such retention of water is the rule in fever is, I think, quite incompatible with the facts, always assuming that the kidneys are not seriously diseased, and are successfully eliminating other matter.

On the effects of variations in urinary water upon the excretion of chlorine.—In health, as is well known, diuresis increases the output of urinary solids, and particularly of sodium chloride, the curves of the excretion of the latter and of urinary water running in general, if special disturbing factors are absent, closely together from hour to hour and from day to day. Further, in malaria this parallelism is fully maintained, as was shown by Traube

and Jochmann, yet more strikingly by Sidney Ringer, and almost all workers since. In this fever alone no retention of chlorine occurs. On the other hand, chlorine retention does occur in anæmia, yet here also, as Laudenheimer (43) has demonstrated, the relation between urinary water and urinary chloride remains distinct, the curves still run fairly parallel, and diuresis prevents retention. It is therefore not a little singular that in fevers other than malarial this relation between chlorine and water is often entirely lost; if the former is being retained, diuresis will not wash it out. Thus Terray's patient, already alluded to, excreted on the first day of the analysis 1450 c.c. of urine and 6·96 grams of sodium chloride, and on the fourth day 2420 c.c. with but 2·90 grams, in spite of the previous daily retention of salt. For reasons already given, and also because it was the last day of fever, the insensible loss is probably considerably under-estimated at 1303 c.c.; yet if we add 80 c.c. for loss by the bowel, the total elimination of water still amounts to 3803 against an intake of 2578 c.c.; that is an absolute loss of 1245 c.c., and probably more, with an absolute retention of 4·99 grams of sodium chloride. Again, a patient of Röhmann's excreted 3250 c.c. of urine at the time of the crisis, yet lost but 2·925 grams of salt—a little less than he took; while one of Cario's cases passed 1450 c.c., and one of Hutchison's 1710 c.c., with no salt at all.

Author's results.—Of my cases, A. H—, No. 1, on caffeine, increased his excretion of water from 706 to 2170 c.c. in the day, a corresponding augmentation in the output of urea, uric acid, sulphur, and phosphorus accompanying the rise; yet the excretion of chlorine fell from ·92 to ·87, the intake being constant, and both figures indicating retention. E. W—, No. 2, before taking sodium bicarbonate passed 970 c.c. of urine; under the influence of the diuretic the quantity rose to 1139, and later to 1507 c.c. Again, C. O. C—, No. 3, on sodium salicylate, increased his output from 669 to 1630, and later 1807 c.c. Yet in both cases but traces of chlorine were passed

throughout. J. C—, No. 8, on digitalis, excreted 1465 c.c. with but ·34 gramme of chlorine; F. H—, No. 17, on five pints of milk and soda water besides, passed 3000 c.c. with but 1·38 g., or but half of what he took; and H. C. M., No. 13, 1780 c.c., containing no less than 85·5 g. of urea, 4·38 g. of potash, and 5·19 g. of sulphuric acid, with but ·11 g. of the halogen. This behaviour, which is quite in keeping with that in relapsing fever where retention of chlorine occurs in spite of diuresis and addition of salt to the food, is in striking contrast to that displayed in health, in anæmia, and in malaria, and furnishes evidence that even if chlorine is retained as saline solution in anæmia when the blood is very watery and rich in chloride, it is not so retained in the febrile state, where the blood is in neither the one nor the other condition.

On the cause of the retention of water in fever.—Granting that a certain relative retention of water may occur, why is this superfluous fluid not excreted? Leyden (6) believed that the fault lay in impaired secretory and excretory activity. This does not appear to be the case as a rule with regard to the kidneys, as the striking results obtained by Sahli and Valentini have shown, and also, less forcibly, mine just quoted above. Again, his own figures, showing the insensible loss with the falling temperature, demonstrate that the skin has by no means lost its function in this respect. Moreover it seems unlikely that, so long as the kidneys are able to deal readily with large quantities of urea and other solids, they should fail to eliminate water were it in excess in the blood. The presumption is, therefore, that unless urea accumulates in the blood, as it may in the typhoid state, any water retained is not in the blood but in the tissues, and analyses of the blood in fever generally confirm this opinion. It was suggested by Liebermeister (22) that in prolonged fever the kidneys failed to eliminate water owing to failing circulation and diminished blood-pressure, and this conclusion has been accepted by many authors, including Reinert (35) and Hutchison (40). It cannot, however,

apply to acute sthenic fevers, and the results of Riva-Rocci and Cavallero are opposed to its acceptance even in typhoid, when the disease runs a favourable though prolonged course. Retention from such a cause would lead to a watery condition of the blood rather than of the tissues. To explain retention in the tissues Parkes (10) put forward the theory that some gelatine-like body having affinity for water was produced therein by the metabolism of fever, and that the retention of water was thus intimately connected with the retention of imperfectly metabolised nitrogenous matter. While this latter conclusion seems to me entirely consistent with the facts, I see no reason to assume that any abnormal product of metabolism is produced. Von Moraczewski's explanation is that the breaking down in the tissues of large organic molecules leads to the production of simpler bodies, whose smaller and more numerous molecules increase osmotic tension, and cause a constant flow of water from the blood into the solid organs.

This theory appears to me to be too mechanical; further, it implies a katabolism far in excess of what occurs. A large meal, rich in proteids, may bring about a katabolism of albuminous molecules in the tissues, such as is rarely attained in the febrile state; further, in diabetes such katabolism is very active, yet in neither case does retention of water take place. Again, it is known that even dead matter, such as gelatine, the substance quoted by Parkes, can take up water and salts dissolved therein in a manner inexplicable by laws of physical diffusion, chemical affinity, or capillary attraction, so that Ostwald has introduced the term "mechanical affinity" to describe this power. It is probable that the living animal cell possesses capabilities of the same nature in at least equal degree, and therefore that if the tissues take up or retain water in unusual quantity, they do so because they have need of it, and not because it is thrust upon them; in fact, that, as Riva-Rocci and Cavallero suggest, it is intimately connected with the pyrogenetic process. The suggestion

which I would put forward involves nothing original, but simply assumes that the earlier stages of metabolism are, as is widely believed, in the main processes of hydrolysis as well as oxidation; it is as follows :—All active living cells are constantly taking up water by an effort of assimilation in which mere chemical and physical functions are the servants of the cell and not its masters. Whether the cell produces for this purpose a substance of high mechanical affinity, or how it achieves its object, need not here be discussed. This water is perhaps combined by the living cell with the first products of its own life, and only again released when these products are fit to be passed into the blood. Now in fever metabolism is abnormally active, hence water is taken up in unusual amount. Further, the complete metabolism of some portion of the disintegrated substance is often delayed till the temperature is falling, and therefore the small quantity of water corresponding to this moiety is likewise held back until this occurs. This hypothesis, like that of Parkes, implies a direct connection between retention of water and retention of nitrogen. A converse suggestion is put forward by von Moraczewski, namely, that the katabolism of fever is itself produced as a result of the invasion of the tissues by water, and a consequent liberation of ions. This theory is certainly original, but apart from the fact that it lays its author open to the accusation of arguing in a circle, it is scarcely conformable with his own results (28, *d*) obtained in anæmia, where the tissues and blood are undoubtedly very watery, and yet retention of nitrogen occurs; nor with those of Straub (45), who has demonstrated that, in dogs, complete deprivation of water, sufficient to produce a loss of fluid amounting in the muscles to 20 per cent. after death, brought about a notable increase in the metabolism both of nitrogen and phosphorus. According to my theory the retention of water is, as a rule, merely relative and not absolute, and is little if at all influenced by the osmotic tension of the body fluids, or tne percentage of salts therein, unless this

be excessive. In connection with this latter subject I would point out that the katabolism of the solid tissues in fever releases, among other things, sodium chloride and water, muscle containing about ·07 per cent. of chlorine; but while most of this water is eliminated, all the salt is apparently retained. This salt produced from the tissues is probably, in ordinary fevers, sufficient to form normal saline solution of all the retained water, and little, if any, of that actually held back in addition can be needed for such a purpose.

The two phenomena, retention of water and retention of chlorides, appear, in fact, to be entirely independent of one another, and have, as I shall presently show, in respect to time of maximum intensity and duration, absolutely nothing in common. I have discussed this matter of retained water at, I fear, inordinate length, because of the great importance attached to it by others, and not on account of any significance attributed to it by myself. It is essential to form some definite opinion on this matter before discussing the behaviour of sodium and chlorine, to which I shall next proceed.

Conclusions as to the excretion of water.—1. Reduction in the excretion of urinary water is a frequent but not a constant accompaniment of fever; it is in general merely the result of increased loss of water by other routes, often preceded by diuresis during the period of incubation, and frequently attended by diminished intake of fluids.

2. A large increase in the insensible loss of water occurs at all periods of fever, but particularly with a falling temperature; it more than balances the urinary diminution, so that the febrile body contains less water than it did in health, the loss growing greater as the temperature falls.

3. The loss of water does not always keep pace during the fever with the loss of solids, but when the temperature falls any superfluous water is eliminated, and probably often more besides, so that the tissues may become unusually dry at this time.

4. Absolute retention of water, the intake exceeding the output, occurs, if kidney disease be absent, only in very severe fevers, where elimination of other matter is also imperfect, and is associated with grave symptoms. In other cases such retention never happens until convalescence is established and the body begins to regain weight.

5. A large loss of water may correspond with a considerable retention of chlorine, and the normal relation between these two excretions is often lost in the febrile state.

6. The small quantity of water usually retained in fever exercises no important influence on the economy in this condition; it is probably combined in the tissues with some imperfectly metabolised nitrogenous matter.

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On the Excretion of Sodium and Chlorine.

Physiological variations.—The normal excretion of chlorine by the urine is variously given as from 5 to 9 grams in twenty-four hours, of soda (Na_2O) as from 4 to 7 grams. The sodium is thus usually insufficient to saturate the chlorine, a small excess of the latter being, according to Zuelzer (1) and I. Munk (2), combined with potassium. The excretion is very greatly influenced by diet, yet a sudden change to a diet poor in salt is not accompanied by an equally sudden fall in its excretion, nor a sudden change to a diet rich therein by an equally sudden rise; in the first case some absolute loss, in the second some absolute gain results. If, however, salt is taken as such, it is nearly all excreted within twenty-four hours unless the quantity is over 10 grams, and even with large quantities the major portion can be recovered from the urine in this time. The conclusion arrived at by Voit (3), from whom these observations are taken, was that in absence of sudden changes almost all the sodium chloride of the food reappeared in the urine. This opinion has been frequently confirmed. (For recent literature see a paper by Straub [4]). In health, and in absence of special disturbing factors, such as the ingestion of sodium in other forms, the excretion of sodium and chlorine run parallel from day to day and from hour to hour, and it is probable that the whole of the sodium is combined with chlorine in so far as is possible in a mixed solution. On the milk diet of the hospital the excretion of sodium and chlorine amounts, in absence of fever, to about 1·75 g. of each. In starvation the excretion of chlorine may sink to ·35 g., and sodium (Na_2O) to ·22 g., a relatively large proportion, about 30 per cent., of the chlorine being combined with potassium; the loss does not, however, cease even after many days of starvation, at any rate in man (I. Munk).

The effects of taking salts of sodium and potassium.—Bunge (5) found that of 12 g. of Na_2O taken as citrate, nearly 9 were excreted the same day; there was a small increase in the output of K_2O, but none in that of Cl. Of 18·2 g. of K_2O taken as a citrate, 12 reappeared in the day, and carried with them 4·5 g. of Na_2O, of which 3·2 were combined with chlorine. No diuresis

was induced by the sodium, and little by the potassium salt. Beckman (6) found a small increase in the excretion of Cl to follow the taking of sodium citrate. The sodium was readily excreted, but the urine was not rendered alkaline unless the daily dose was equivalent to 15 g. of Na_2CO_3. The excretion of ammonia was reduced.

The excretion by the bowel.—The loss of chlorine by this route is small in health, but may be considerable if diarrhœa occurs. Under normal conditions, and on a fixed diet of meat, bread, butter, milk, and 5 g. of salt, Röhmann (7) excreted from a mere trace to ·162 g. of NaCl per day. The excretion of soda was found by Salkowski (8) to vary between ·068 and ·226 g.

The excretion by the skin.—Human sweat contains from ·22 to ·36 per cent. of sodium chloride, so that it is possible for a considerable loss of salt to occur in this way where sweating is profuse. As analyses necessarily only apply to sensible sweating, and that copious, it is difficult to say what, if any loss of sodium chloride occurs where sweating is insensible. It seems, however, unlikely that much salt is excreted under these conditions, or it would be found on the skin, and it is usual to neglect this source of error in considering the salt balance in absence of obvious perspiration.

The effects of fever.—That the excretion of chlorine by the kidneys may be reduced, under pathological conditions, to a marked extent, is an old observation. Prout (9) observed such an occurrence to be common shortly before death. Simon (10) stated that a similar phenomenon occurred in "phlogoses," nor did he claim the discovery. Heller (11), again, was well acquainted with this occurrence; he observed it in pneumonia, pleurisy, phlebitis, pericarditis, and typhus fever, and noted that the chlorides might completely disappear. A somewhat unfortunate prominence to the reduction of this excretion in pneumonia was subsequently given by Redtenbacher (12), who, in a series of eighty cases of this disease, found great reduction or complete disappearance of the urinary chloride in every one during the period of exudation, with a return later during resolution. His analyses were qualitative only. The next to study the question was Beale (13),

who published quantitative analyses, and confirmed Redtenbacher's results. The impetus given shortly after to the study of metabolism by the introduction of Liebig's method of urea estimation resulted in a large amount of work being done also on the excretion of chlorine, and it was found by Parkes (14), Moos (15), Buchanan (16), Wyss and Bock (17), Squarey (18), Riesenfeld (19), Unruh (20), Murchison (21), and others, that great reduction, and indeed sometimes disappearance of the urinary chloride, was in no way characteristic of pneumonia and phlogoses, but occurred in typhoid, typhus, and relapsing fevers, in acute rheumatism, acute bronchitis, and erysipelas. Subsequently the same was observed by Ringer (22) and Gee (23) in scarlet fever, in morbilli by Brattler (24), in acute phthisis by Parkes, in variola by Robin (25), lately also in broncho-pneumonia by Terray (26), and in tetanus by Schwarz (27), while I have seen it in diphtheria and tonsillitis. Experimentally, great reduction in the urinary chloride which could not be accounted for by reduced intake has been observed in dogs by Senator (28), after injection of pus; by Noël Paton, Dunlop, and Macadam (29) after injection of diphtheria toxin, also after the latter by Dmitriewski (30). With extracts of dried cultures of *B. pyocyaneus* and *coli* this experimenter's results were not constant. According to Moos (15), who quotes also Tomowitz, the excretion of chlorine is not reduced in meningitis. If this is always so it is a very interesting point, and requires more investigation. Complete disappearance of the chloride has been frequently observed, not only in pneumonia, but also in typhoid, typhus, and relapsing fever; it has further been noted in morbilli, variola, and acute phthisis. In typhoid this phenomenon has been considered to be of evil omen, but Parkes stated that it was not unfrequently followed by recovery. A further reduction in the excretion of chloride, where this had not been very low, has been observed when pneumonia has intervened in the course of typhoid fever; it is, however, possible that the

same would have occurred had some other acute febrile complication befallen the patient. Of two cases of typhoid with pneumonia published by Unruh, in one the urinary chloride is never unusually reduced, and in the other it increases with the onset of the complication. The presence of this phenomenon is therefore of small diagnostic value. On the other hand, its absence may, according to Hutchison (31), be useful in distinguishing from pneumonia a pleural effusion, for the chlorides are not so often reduced in the latter. In long-continued fevers, such as typhoid and rheumatic, the excretion of chlorine does not always remain abnormally low throughout the attack, even if it has been so early therein. Of eighteen cases of typhoid studied by Moos (15), the average daily excretion of NaCl in the urine was, during the first week, but ·9 g., during the second 1·1 g., during the third 3·4 g., and during the fourth 10·7 g.

Decreased excretion of sodium was first noticed by Salkowski (8) in the course of pneumonia, and typhoid, typhus, and relapsing fevers; also in erysipelas. He showed that after the fall of the temperature the sodium returned to the urine immediately or after a delay of a day or two, and sometimes in considerable quantity. The return of the sodium was not necessarily accompanied by a fall in the output of the potassium. The output during fever was usually between ·2 and and ·4 g. of Na_2O daily, but during the first days of the attack might be considerably more, even 2·45 g. with a temperature of 39·5° to 40°; again, some cases showed no more reduction than might be attributed to diet. Generally, however, the potassium was in excess of the sodium during the fever, while after it the sodium was in excess of the potassium. In typhoid fever the loss by the bowel was considerable. Zuelzer (1) has published a few analyses which confirmed those of Salkowski. Von Moraczewski (32, *d*) has also recorded a few cases: in typhoid he found little reduction in the excretion of sodium, in pneumonia the output was very small after

the temperature fell, in malaria there was a large increase with the rise of temperature, in phthisis the excretion scarcely altered until the temperature fell; it was then very small. Von Limbeck (33) records analyses of several cases, and his results also differ from those of Salkowski, for in two cases of phthisis and one of morbilli sodium is, during the fever, excreted in excess of potassium, though not in large amount. Pick (34) supplies analyses of two cases of pneumonia, but only in the critical and epicritical period; also Noël Paton, Dunlop, and Macadam's work included analyses of sodium; I shall have to allude to these presently.

That chlorine was definitely retained in the body in fever was concluded by many of the older writers, who observed that addition of chloride to the diet caused no increased excretion; among these may be mentioned Heller (11), Howitz (35), Buchanan (16), Wyss and Bock (17), and Murchison (21); but the first to actually demonstrate that this was the case by analyses of the food, and also of the fæces, as well as the urine, was Röhmann (7). His work has been confirmed by Terray (26), who investigated not only the above, but the sweat and sputum also; by Hutchison (31), by von Moraczewski (32,*f*), who combined with analyses of urine, fæces, and food the addition of large quantities of salt to the last; by Roehrich and Wiki (36), by Achard and Loeper (37), and by Hijmans van den Bergh (38).

Lost by other routes.—The excretion of chlorine by the bowel in fever was shown by Röhmann to remain small as in health. Terray's figures are even lower than Röhmann's, so that in absence of diarrhœa the loss in this way is negligible.

The excretion of sodium in the fæces has been shown by von Moraczewski (32, *d*) to be less than that of chlorine. Two analyses of my own confirm this opinion, although the patient was taking sodium citrate. If diarrhœa is present, however, the loss may be considerable, as has been shown by Salkowski and others whom he quotes.

Herringham (39) has failed to discover any sodium in the fæces or even in the urine in patients dying of renal disease. This result is certainly remarkable, and more work on the subject is desirable.

The excretion of chlorine by the skin was studied by Terray in a case of pneumonia. He found the percentage of sodium chloride in the sweat to be ·25—·3 per cent., or the same as in health. The total excretion was not estimated, and it is obvious that during the crisis of pneumonia it may be far from negligible.

The composition of pneumonic sputum has been investigated by Beale, Terray, Hutchison, and Roehrich and Wiki. It is generally agreed that it contains much sodium chloride, which may amount to 18 per cent. of the solid matter or even more. According to the authors last mentioned this percentage of salt increases from the third to the twelfth day; according to Hutchison it varies directly with that of the water it contains; in any case, however, the total loss is small even in pneumonia, not over ·5 g. of NaCl daily, while in other fevers no loss will in general occur from this cause. It is seen, therefore, that unless chlorine is excreted in gaseous or organic form, the only source of loss which has not been measured is that by the skin. In the study of chloro-metabolism it is therefore particularly desirable to avoid diseases attended with sweating. On the other hand, there is a source of gain to the body fluids which likewise can only be conjectured, namely, the solid organs, which must yield salt in considerable amount as the result of their metabolism, and thereby increase the store in the circulating fluids. Estimations of the intake and output can therefore never furnish an accurate idea of the condition of these fluids in this respect.

Turning now to my own analyses, I have excluded cases taking drugs calculated to disturb chlorine excretion, as also all those where any addition to the diet was made; there remain seventy-six twenty-four-hour samples of patients not widely dissimilar in age, all of whom were

taking the same food, namely three pints of milk and one egg. These figures I have grouped as follows.

Author's results.—Twenty-four hours' excretion of chlorine (Cl) in grams:

		Number of samples.	Maximum.	Minimum.	Average.
1.	With temperature of 103° and over	23	3·39	·10	·79
2.	„ „ 102°—103°	7	·84	·07	·37
3.	„ „ 101°—102°	14	1·66	·04	·42
4.	„ „ 100°—101°	11	·52	Trace	·22
5.	„ „ under 100°	21	1·18	Trace	·36

Of fifty-five samples for temperature of 100° and over the average is ·53, of twenty-one samples for temperature of below 100° the average is ·36.

The average excretion of the test cases without fever on the same diet was 1·72, so that there is a difference of 1·19 and 1·36 respectively. Hutchison estimates the daily retention of sodium chloride in pneumonia at about 2 g. or 1·2 g. of chlorine; it would seem, therefore, that there is no noteworthy difference in this respect between pneumonia and the fevers here considered. It must, however, be borne in mind that mine are not average cases, but cases selected from a large number over a period of six years on account of their special suitability and high temperature.

The minimum excretion of chlorine is not usually attained with the onset of the fever; indeed the output may at first exceed the intake, though this is uncommon. Nevertheless it is generally agreed that the reduction of the urinary chloride in fever, and on a diet containing a moderate quantity of salt, is both more rapid and more complete than that occurring in conditions of salt starvation without fever. According to Roehrich and Wiki the excretion in pneumonia is usually already almost at its minimum on the third day. In my cases the smallest output often occurs when the temperature is low, and the average excretion is seen to be less with a temperature below 100° than above it. The latter, however, must have

been high previously in order to achieve this result. This observation is quite in keeping with that of other workers, the maximum total retention, both in pneumonia and other fevers, being, in fact, usually attained after the temperature has fallen, and, indeed, two days after and frequently more. One of Beale's cases of pneumonia, as also one of Röhmann's, showed this late retention; Parkes stated that the return of the chlorine may be delayed for eight days; Fraenkel (40) noticed an interval of several days between this return and the crisis in pneumonia; Wyss and Bock the same in relapsing fever, and Terray, Hutchison, and von Moraczewski are agreed upon this point. Roehrich and Wiki say that, if the temperature fall very rapidly a return of the chlorine occurs usually within twenty-four hours, but their figures for the average excretion, 2·80 on the ninth, 4·97 on the tenth, 6·57 on the eleventh, and 7·71 on the twelfth day, all reckoned as NaCl, show that this return cannot as a rule be considerable, and they acknowledge that for two or three days the excretion may remain very small. A more prolonged delay in the return of chlorine indicates to them a fatal issue or the onset of a complication. Baginski (41) has observed that in children also the chlorine is not excreted in large amount until several days after the fall of temperature. The same is shown by von Limbeck (33) in a case of morbilli as well as one of pneumonia, the return in the former case being due to food.

The return of chlorine to the urine is, in pneumonia, frequently though not always abrupt, the output then exceeding the intake, as is well shown in Hutchison's charts. This excess comes, in all probability, almost entirely from the lungs, for after other fevers such a rise in the excretion is extremely uncommon. Thus Squarey (18), working at the London Fever Hospital, found that of sixteen cases of typhus, all of whom showed reduced excretion during the fever, in one only did the chloride regain the normal when the temperature fell, in eight it did so at the end of the first week of convalescence, in

five at the end of the second, and in two not until the end of the third week. Further, in no case did any excretion occur beyond what might have been due to change of diet. Ringer (22) and Gee (23) observed that in scarlet fever the chloride excretion slowly regained the normal but never exceeded it, and many of Unruh's cases suggest a similar conclusion. Terray (26) found that in a case of typhoid during thirteen afebrile days but little of the chloride previously retained reappeared, and, more remarkable still, his experience with a case of pneumonia was the same. In both cases food, urine, and fæces were analysed. Lastly, von Moraczewski (32,*f*) in a long series of cases of pneumonia, many of them treated with much sodium chloride, seldom records any considerable excess of the output over the intake during the period investigated. An exception to the rule as to fevers other than pneumonia would seem to be furnished by variola. Here the return of the chlorides is, according to Robin (25), frequently abrupt, corresponding with the first fall of temperature and a reduction in the excretion of urea. My own experience is that, in the fevers I have studied, an excretion of chlorine in excess of the intake is quite exceptional; I have not, however, extended my observations over long periods after the fall of temperature. Not only is there in general no increase in the urinary chloride which cannot be referred to diet, but, on the contrary, not rarely, in spite of a normal or subnormal temperature, and in spite of a practically normal diet with as much salt as desired, the excretion may remain during the first days of convalescence almost or quite as low as ever. Von Moraczewski, indeed, remarks with regard to this matter that the absolute daily retention is greatest of all after the temperature has fallen, and only slowly diminishes. Again, in his scheme of curves (32, *d*) for excretions during and after fever, chlorine is shown returning gradually to the normal, but never rising above it. I have collected from my own cases of scarlet fever and morbilli sixty-six samples where the patients had

commenced taking fish or meat diet; in seventeen the excretion is under 1 g., in seven not over ·1 g., and in one (W. R., No. 26) a mere trace. The average is but 2·44 g. It is evident, therefore, that during early convalescence not only the total retention of chlorine, but even the daily additions thereto, are greater than at any previous period. Now Cetti (2), after six days of starvation, when he returned to a food containing sufficient salt, excreted on the first day ·28 g. of chlorine, that is considerably more than did seven of my cases. We have, therefore, this remarkable anomaly, that the organism at the end of perhaps four or five days of fever, during which it has been regularly excreting less chlorine than it took, may exhibit a salt hunger actually in excess of that which it displays after six days of total abstinence, during the whole of which sodium chloride is being lost. I may mention here that Sollmann (42), in what is, I think, the very latest contribution to the literature of this subject, arrives at the conclusion that the organism in fever behaves as it does when in a condition of salt starvation, and he attributes this solely to deficient supply in the food. While I accept his conclusion, his explanation of it seems insufficient, for the salt hunger exhibited in fever, as is indeed demonstrated by work done by himself in conjunction with Hatcher (43) on cases of typhoid fever, is much in excess of that observable in health on a diet of milk. The matter has, in fact, been studied by Javal (44), who placed a healthy man of 70 kilos. weight on a milk diet for six days. The intake of sodium chloride was 4·08 g. daily, the output 8·2, 6·0, 4·8, 2·2, 2·5, and 3·4 g. The average was thus 4·5, or in excess of the intake, the retention during the last three days failing to balance the previous loss. On taking an extra 10 g. of salt for two days, 7·2 and 13·0 g. were excreted. There was thus retention of 7 g. on the first but only 1 g. on the second of these days. This is very different from what occurs in fever. Some other explanation must therefore be sought for the febrile salt hunger than that

advanced by Sollmann. Before leaving this subject I must mention a discovery made by Roehrich and Wiki which seems to me of much interest. They found, in six cases of pneumonia, an extraordinary hyper-chloruria for several days about the end of the fourth week,—that is to say, some time after the patient had become perfectly well, and when he had long been taking ordinary food. This excretion might amount to as much as 30 g. of sodium chloride in twenty-four hours, and it occurred in all the cases where it was looked for whose convalescence was uninterrupted. I cannot find other workers who have continued their analyses long enough to observe this phenomenon, so that, as Roehrich and Wiki confined their attention to cases of pneumonia, it is not known whether the same occurrence is noticeable after other fevers. Such an event after an attack of pneumonia is, however, scarcely explicable if retention of chlorine is due merely to retention of water, or to deposition of sodium chloride in the pulmonary exudate. Indeed, it suggests that chlorine is stored up in some indiffusible and probably organic combination, and for some definite purpose.

To sum up, the retention of chlorine is often small or absent early in the fever; this is merely due to the fact that the normal body contains an excess of salt, and is in no way comparable to the increased excretion which occurs in malaria. The store increases, and frequently by daily larger additions as the temperature falls, so that not only the maximum retention, but the largest addition thereto, commonly occurs some days after the fever has entirely ceased. The retention of this substance offers, therefore, as I have already indicated, a striking contrast to that of water and nitrogen where this occurs. The latter is most obvious at the height of the disease, and begins to relax as the temperature remits, while the whole of the retained water, and probably often much more besides, is eliminated when the temperature falls, and carries out much, if not all, of the retained nitrogen before the maximum retention of chlorine occurs.

On the relation of sodium to chlorine in the urine of fever.—Comparatively little work has been done on this subject. Salkowski published but three series of parallel analyses, all of them upon cases of pneumonia—a disease peculiarly unsuited to the study of this question. I give here the figures of one of these cases, and have added in brackets the Na_2O which should correspond with the NaCl found by chlorine estimation.

Date.	Temp.	NaCl.	Na_2O.	Na_2O found.
15	40·7°	1·838 =	(·974)	·163
16	39·6°	3·690 =	(1·955)	·431
17	39·7°	2·980 =	(1·536)	·271
18	36·8°	Not estimated		—
19	37·0°	8·683 =	(4·602)	5·486
20	37·1°	19·267 =	(10·212)	9·022

The diminution of sodium is thus more marked, and its return more abrupt. In the other cases also some want of correspondence is found, but on the whole the two excretions run together. Salkowski drew the conclusion that sodium is retained exclusively as sodium chloride in all fevers where retention occurred. This conclusion, though universally accepted, is scarcely justified, because it is not disputed that sodium chloride is stored in the lung in pneumonia. What, however, we want to know is how sodium is stored in other fevers. Salkowski throws no light on this problem.

A few isolated analyses by Zuelzer add little to our knowledge because they form no continuous series; it is, however, noteworthy that he draws the conclusion that during fever, as in starvation, the proportion of chlorine combined with potassium is relatively high, while after fever it is low. Most interesting, however, are the results of von Limbeck; for while in malaria, erysipelas, and phthisis his chlorine and sodium run parallel, this is far from being so in a case of morbilli and one of pneumonia. I reproduce his results in so far as they illustrate my point.

Morbilli.	Na_2O.	HCl.	Pneumonia.	Na_2O.	Cl.
1. Fever	... 1·03	... ·127	1. Fever	... ·869	... ·46
2. No fever	... 1·64	... ·135	2. No fever	... 1·633	... ·44
3. „	... 2·92	... ·256	3. „	... 4·867	... ·19
4. „	... 2·54	... ·146	4. „	... 4·872	... 1·93
5. „	... 3·90	... 2·565	5. „	... 3·334	... 1·57

It is seen that the return of the sodium bears no relation to that of the chlorine, but is much earlier, a large excretion of the former, in the case of pneumonia, coinciding with almost complete retention of the latter.

Next we have the work of von Moraczewski (32, *d*). In a case of pneumonia no correspondence appears between sodium and chlorine excretion, they vary irregularly and independently. In a case of phthisis, sodium excretion is nearly doubled during the hours of fever, while chlorine falls. In a case of typhoid fever, chlorine and sodium indeed correspond in the urine, but, when we examine the balance of the intake and output, we find that much of the retained chlorine is not combined with sodium. Again, in one of Pick's (34) cases of pneumonia, complete lack of parallelism is shown between the two excretions, a change from ·647 to 3·641 g. Na_2O being accompanied by little alteration in the chlorine output, which is 3·643 the first day and 4·106 the next. Pick attributes the post-febrile alkalinity, which he observes to occur frequently in the urine of pneumonia patients, to the return of the sodium. He thus assumes that it is not combined with chlorine, but does not comment upon the fact further.

Finally, in the work of Noël Paton, Dunlop, and Macadam (29) on the metabolism of fever in dogs, there is found a complete divergence of the chlorine from the sodium, for while the former excretion was remarkably reduced, and equally so whether the animal was taking salt and previously excreting much chloride, or whether he was not, no corresponding change was produced in the excretion of sodium. These authors suggest that the chlorine is retained in combination with albumen.

This is a conclusion which suggested itself to me before

the publication of their paper, in consequence of the want of correspondence which I noticed between the sodium and the chlorine in the case of F. J—, No. 25, in March, 1899. I shall have to discuss this matter presently, for it presented the problem in a totally different aspect to me, as one of soda and chlorine metabolism, and not a matter of saline solutions. I was not then acquainted with the work of von Limbeck or von Moraczewski.

Turning now to my own work, I have carried out daily parallel analyses of sodium and potassium with not only chlorine, but usually the other two acids as well, in seventeen cases, which may be divided into groups as follows:

Author's results.

A. Five cases where sodium and chlorine run parallel throughout, namely, P. K. No. 7, C. D. No. 9, H. J. B. No. 10, H. G. B. No. 11, and T. E. No. 28.

B. One case, F. P. No. 33, where sodium is at the commencement of the analysis in excess, but subsequently runs parallel with chlorine.

C. Two cases, F. H. No. 17, and V. B. H. No. 16, where the converse happens, chlorine being in excess at first.

D. Seven cases where sodium and chlorine run parallel through the fever, but diverge with the first conspicuous fall of temperature; they are J. C. No. 8, H. C. M. No. 13, G. B. No. 14, J. O. S. No. 15, F. J. No. 25, W. R. No. 26, and W. H. No. 18. Here the divergence is always the same, a more or less abrupt rise in sodium without corresponding rise in chlorine,—in fact, some times synchronous with the minimum excretion of it, as in von Limbeck's case.

E. Two cases where sodium and chlorine never were parallel; they are V. R. G. No. 12, the only case of relapse; and M. I. No. 27, the only fatal case of the whole series.

The cases where sodium and chlorine run parallel are therefore in a minority, so that my work confirms that of

von Limbeck, von Moraczewski, Noël Paton, and Pick rather than that of Salkowski. It is true that four cases, H. C. M., G. B., J. O. S., and W. H., were taking at some time drugs calculated to disturb their excretion. This matter I will now discuss.

On the effects of the administration of sodium, potassium, and chlorine salts in fever.—The first to study this matter was Heller (11); he administered sodium chloride to patients in febrile conditions whose urinary chlorides were reduced or absent, and found that it was not excreted. This observation was afterwards confirmed by Howitz (35), to whom the discovery has been erroneously attributed. Redtenbacher (12) administered hydrochloric acid in doses of ʒss of the Ac. Muriat. dil. daily to a case of pneumonia where urinary chloride was absent; none of it reappeared. Buchanan (16) gave twelve drachms of salt to a case of typhus on the ninth and twelfth days of fever, yet scarcely a trace could be discovered in the urine up to the time of death on the seventeenth day. There was no diarrhœa or pulmonary complications, and examination of the blood after death showed but a trifling increase therein, quite insufficient to account for the retention.

Buchanan made this significant comment :—"It is probable, therefore, that the chloride attaches itself to some solid tissue, or that the excess is diffused alike through the tissues, *and its retention is intimately connected with the febrile condition.*"[1] Buchanan (16), as I have already pointed out, was no believer in the retention of water, but he fully recognised the retention of chloride apart from exudations, and its intimate relation to the febrile process. Again, Wyss and Bock (17) found that both sodium chloride and hydrochloric acid administered during the paroxysm of relapsing fever produced no rise in the excretion of chlorine. They examined a spleen after death, but found no increased percentage of chloride,

[1] The italics are mine, not Buchanan's.

though, owing to its great enlargement, the total content therein was considerable. Squarey found in the urine of a case of typhus under care of Murchison (21) but a trace of chlorine, though the patient was taking at one time nitro-hydrochloric acid every three hours, and at another two drachms of salt on two successive days.

Similar experiments with sodium chloride have been repeated recently by Hutchison (31), and by Roehrich and Wiki (36), the latter having given as much as 12 grams of sodium chloride in the day without increasing the excretion, by Achard and Loeper (37), and Hijmans van den Bergh (38). Again, Terray (26) quotes experiments by Remboldt, showing that chlorine given as calcium chloride in pneumonia was retained equally with that given as chloride of sodium. Hatcher and Sollmann (43) have administered sodium chloride in large doses, as much as 60 grams a day, to cases of typhoid, yet but a fraction of it was excreted by the urine. Where a dose of 15 grams was given on two successive days the urinary chloride was but ·95 g. NaCl the first day, and 3·70 the next. The most careful work is, however, that of von Moraczewski (32,*f*), done on cases of pneumonia. He found that not only was chlorine retained when given as sodium chloride, but also when given as chloride of potassium. He used KCl in 5-g. doses, and NaCl in doses of 5 to 11 g. in twenty-four hours, and found that about 90 per cent. was usually stored up. Sometimes not only was all the addition held back, but some of that of the food besides. Urine, food, and fæces were all studied. The largest retention amounted to an average of 9·23 grams of chlorine (Cl) daily for three days, and that, too, while the temperature was falling, and water was therefore probably being lost rapidly by the skin. In another case the average retention was 7·4 g. of Cl for two days before, and 6·11 g. for two days after the crisis. We see, therefore, that chlorine is stored up, whether given as hydrochloric acid, nitro-hydrochloric acid, chloride of calcium, chloride of potassium, or chloride of sodium, that the

amount so retained may be very large, and that it is wholly independent of the retention of water.

Author's results.—Turning now to my own results, the effects of chlorides has been so thoroughly worked out that more observations are scarcely necessary. What is required is to study the influence in fever of substances which affect, in health, the excretion of chlorine without introducing any, and to follow the behaviour of sodium. This I have done. Sodium chloride given with sodium salicylate, in the case of W. R. No. 6, caused very little change in the excretion of chlorine. A larger dose, in the case of C. D. No. 9, did so only when salicylate was added; there was then a decided increase in both sodium and chlorine. Larger doses of salicylate later increased the potassium and phosphoric acid. On the other hand, a sodium salt having no specific action on cell life—namely, the citrate, which is freely excreted in health—is in the febrile state absolutely retained, as is shown by H. C. M. No. 13, and G. B. No. 14; it is not excreted by the urine nor yet by the fæces, but is returned through the kidneys without the accompaniment of chlorine when the temperature falls. Potassium citrate given to V. B. H. No. 16, with a mild attack of scarlet fever, produced, in spite of diuresis, but small excretion of sodium or chlorine, but the potassium was excreted freely. Given to J. O. S. No. 15, as the temperature was falling, the same drug produced a decided increase in the excretion of sodium, but retention of chlorine continued. Finally W. H. No. 18, who took both citrates in large doses before the temperature fell, retained the sodium but excreted the potassium; when the temperature fell he began to excrete the sodium also, the return of the latter corresponding with the minimum excretion of chlorine. We find, therefore, that potassium salts, which in health carry out sodium and chlorine from the blood, fail to do so in fever. When, however, the temperature falls they carry out sodium, but not chlorine. They are themselves excreted freely. The conclusion to be drawn, as it seems to me, is that some

sodium, at any rate, plays a part in the defensive mechanism which cannot be played by potassium, and the purpose of which is achieved when the temperature falls; while chlorine in some form, with or without sodium, plays another part, whose function is more prolonged. This leads to the next question: Why are sodium and chlorine retained in fever?

On the cause of the retention of sodium and chlorine.— I assume that such retention occurs, the old hypothesis of Traube (45) that there is merely imperfect absorption of salt having only historical interest.

The first explanation offered for retention was that of Redtenbacher (12) and Beale (13), and applies only to pneumonia,—namely, that sodium chloride is stored up in the lung affected. Beale demonstrated the presence of considerable quantities of salt in the pulmonary exudate, and his observations have been since confirmed. Terray's (26) work is the most complete, as he examined the whole lung, and his figures show an excess of 6·88 g. NaCl in a right lung completely hepatised over that in a right lung that was healthy. We have here an explanation of the difference in the return of chloride in this and other fevers.

When, however, we come to consider these last, it is obvious that the value of Beale's discovery lies only in the lesson it teaches that cases of pneumonia should be rigidly excluded in the study of chlorine excretion, a lesson even now insufficiently appreciated. However, even in pneumonia, Terray, Hutchison, von Moraczewski, and all later workers agree that the chloride in the lung is insufficient to explain the whole phenomenon, but, as in other fevers, a retention occurs for which the pulmonary exudate is not responsible.

The next hypothesis is that of Röhmann, which was accepted by Cohnheim (46). He concluded that sodium chloride was held in the blood in combination with some albuminous product of metabolism, and that this compound being indiffusible the salt so combined was excreted only

when the excess of albuminous waste had been converted into urea, and its inorganic moiety released. This theory was based on that of Forster (47), that sodium chloride in the blood is partly free and partly combined; moreover Röhmann showed that in a dog albuminous food produced a relative diminution in the chloride excreted. This theory cannot be accepted as it stands for many reasons. Firstly, there is evidence that the blood in pneumonia contains not more, but less sodium chloride than in health. Secondly, Hutchison (31) fails to find any abnormal combination of salt in pleural effusions occurring in the course of this disease, though it has been shown by Runeberg (48) that such effusions are a sure index of the composition of the blood in respect to salt. Thirdly, there is no relation between the excretion of chlorine and the excretion of urea, retention of the former surviving the post-critical nitrogen excretion. Fourthly, as pointed out by Klees (49), there is very little return of the retained chlorine to the urine after an attack of typhoid fever, though in this disease, according to Röhmann, retention reaches its limit, so that no more can be taken up, and a new equilibrium is established. Lastly, the theory does not explain the anomalous behaviour of chlorine in malaria.

The next theory is that of Klees (49),—namely, that retention occurs because the kidneys are incompetent. This was the explanation advanced by Fraenkel (40) for retention of nitrogen, and it is even less applicable to the retention of chlorine. Klees found that when renal irritation was produced in rabbits by subcutaneous injection of glycerine, the excretion of chlorine fell. Hutchison, repeating the experiment, finds no diminution which cannot be referred to diminished intake. Nevertheless we may accept Klees' results without adopting his conclusions. For Menarinini (50), producing nephritis in dogs by administration of cantharides, found reduced excretion both of chlorine and phosphorus in spite of constant diet and absence of diarrhœa; nevertheless when sodium chloride or phosphate, or potassium iodide was injected

subcutaneously, they were excreted as freely as by a normal animal. This author concludes that the first result was in no way due to defective filtration by the kidneys, but to altered interchange between the blood and tissues ; moreover, he confirmed this opinion by finding some increase of chloride in the liver. The kidneys showed signs of nephritis. It may further be mentioned that Fleischer (51) found that patients with granular kidneys excreted iodides perfectly, but not phosphates. Again von Noorden (52) has grouped urinary excretions in two classes : those readily eliminated in acute nephritis, and those eliminated imperfectly : while urea, phosphates, and potassium appear in the latter group, uric acid and chlorides are found in the former. I have myself seen chlorides much reduced in nephritis, but only if other excretions were correspondingly diminished, unless the temperature has been high, and even under the last condition I think patients with nephritis excrete quite as much chlorine as others without nephritis, and with an equal degree of fever. Hijmans van den Bergh (38) has studied this matter carefully, and finds that the excretion of salt in acute and chronic nephritis oscillates considerably, but is never so reduced as in fever, further added salt is excreted, though less rapidly than in health. The excretion of chlor-free molecules does not run parallel with that of sodium chloride. While, therefore, it is possible that, in certain conditions where there is great renal inadequacy, the kidneys may be to some small extent responsible for retention of chlorine, such an explanation of it can very rarely be justified. Indeed, as Hijmans van den Bergh remarks, the fact that the chlorine in the blood is not increased but diminished, is alone a very serious obstacle to the acceptance of the theory of Klees.

We have now to consider the theory advanced by Carl Schmidt (53) and elaborated by Laudenheimer (54), Terray (26), and von Moraczewski (32),—namely that the retention of chlorine is merely secondary to the retention of water. Laudenheimer and Terray suppose that

the sodium chloride forms with the water normal saline solution, being retained in such proportion as to achieve this object, and the latter's figures already quoted are supposed to demonstrate this relation. Unfortunately, however, these figures, when corrected by those of Leyden, the very authority to which Terray appeals, show the exact opposite to what he maintains,—namely, a large absolute loss of water, reaching its maximum at the very time when retention of chlorine is most complete. Again Laudenheimer quotes experiments by Pontfick, showing that normal serum of dogs produced no diuresis when injected into the circulation, and by Kultz showing that normal saline solutions were also tolerated, but stronger solutions were not. In consequence he, and likewise Terray argue that the organism is tolerant of increase in the volume of its fluids, but not of change in their salt composition. To this I would reply that we are not dealing with additions of serum, so that Pontfick's experiments are not to the point, while Kultz's have not been confirmed,—indeed, there is much evidence that salt solutions of all strengths are very ill tolerated, and produce diuresis quite out of proportion to the added fluid. In proof of this statement I would refer to the work of Magnus (58), of Thompson (55), and Sollmann (56), while references to others will be found in their papers. In any case by no possibility could the theory of Laudenheimer and Terray explain continued retention of chlorine at the rate of 6 grams a day after the temperature has fallen, and all excess of water has been eliminated, nor yet can it account for the retention of hydrochloric and nitro-hydrochloric acids, or of calcium and potassium chlorides.

Von Moraczewski does not maintain that normal salt solution is aimed at, he regards the taking up of salt by the tissues as, indeed, merely secondary to the taking of water, but the osmotic equilibrium thereby attained is, he thinks, not the normal, but one entirely new, and due to molecular conditions wholly abnormal resulting from fever. He seems, indeed, to set scarcely any limit to the quantity

of salt which may accumulate. He has done an immense amount of work on the subject, and his opinions must command much respect, the more so that they are accepted by C. A. Herter (57) as a complete and satisfactory explanation of the whole phenomenon.

Von Moraczewski's earlier papers (32, *a* and *b*) deal with the salts of the blood in carcinomatous and simple anæmias, and the conclusion arrived at is in conformity to that of earlier workers,—namely, that the blood is more watery and more rich in chlorine than it is in health. Turning next his attention to pneumonia (32, *c*) he finds the blood neither more watery nor richer in chlorine than normal blood, he therefore predicts that the retained chlorine will be found in the tissues. In his next paper (32, *e*) this matter is taken up, and the conclusion arrived at that the solid organs both in anæmia and pneumonia are more watery and richer in chlorine than is the case in health. He supposes that a watery condition of tissues is a constant feature of disease, carrying with it, as a necessary consequence, increased richness in chloride, that the blood being diseased in anæmia suffers this change along with the tissues, but in fever the tissues suffer alone. We are led to suppose that the blood is not diseased in fever. A curious comment on these conclusions is furnished by the same author in a later paper, where he remarks, "Every one knows that cases of pneumonia which do not retain chloride, and excrete little phosphate, commonly end fatally." I would add further that, whereas moderate doses of toxin cause chlor-retention in animals, lethal doses of bacteria do not do so. In other papers (32, *d* and *g*) he propounds the explanation already referred to in discussing retention of water,—namely, that the katabolism of fever, by breaking up large into small molecules, raises osmotic tension in the tissues, and an invasion of these by both water and salt results. In a later paper (32, *f*) he adds that the process of sucking up of water and salts must continue until the molecular concentration of the organs balances that of the blood. Now

it seems to me more probable that the organism would achieve the above result by passing the aforesaid molecules produced by metabolism at once from the tissues into the circulation, and that this is what occurs, so that the osmotic tension in the solid organs is not increased. Again, his theory seems to be too mechanical, and inconsistent with what is known of cellular pathology, and with the remarkable protective functions which the blood and tissues are known to possess.

The blood in fever contains only slightly less chlorine than in health, yet while the kidneys in the latter condition excrete a urine containing about 1 per cent. of salt, in the former state they may produce an even larger quantity containing no salt at all. This phenomenon, as is pointed out by Hutchison and Sollmann, is quite irreconcilable with any laws of mechanical filtration or diffusion. Why should von Moraczewski and Herter deny to the living cells of other organs, powers displaced so conspicuously by those of the kidney in the very condition under discussion? Further, the theory fails to account for the total lack of correspondence between excretion of water and of chloride, which von Moraczewski himself, unlike Terray and Laudenheimer, quite acknowledges. His explanation of this anomaly is far from satisfactory, and is as follows:—During fever there is a flow of water from the blood to the tissues, carrying to them salts of the blood, rich in chlorine, but poor in nitrogen and phosphorus, after fever the current is reversed, carrying with it to the blood, salts of the tissues, poor in chlorine but rich in phosphorus and nitrogen. Why this tide which carrried salts of the blood to the tissues should not again, in like manner, carry these same salts out again, does not appear. According to this author the tissues are loaded with chlorine, and if this really is so, the only reason, as it seems to me, why this chlorine is not given up with the water, must be that it is retained actively for a definite purpose or in some indiffusible form, *e. g.* in combination with albumen.

An interesting antithesis to the theory of von Moraczewski is furnished by Hijmans van den Bergh. This author likewise regards abnormal osmotic relations as the key of the problem, yet is his idea the exact opposite of the above worker. He considers that in fever the blood is rapidly flooded with products of metabolism, partly as a result of increased production thereof, and partly because, from various causes, there is a renal inadequacy which retards their elimination. A state of affairs is thus produced comparable with that brought about either by flooding the circulation with sodium sulphate, or by removal of the kidneys, the osmotic tension of the blood rises as compared with that of the tissues,—the converse, be it noted, of von Moraczewski's hypothesis—and hence sodium chloride is unable to pass from the tissues into the blood, but only from the blood into the tissues. As a result the quantity in the tissues is increased, while that in the blood is reduced, and the diminished excretion by the kidneys is due to this reduction of the salt content of the blood. The difficulty of accounting for the failure to eliminate added salt, he explains by quoting the work of Magnus (58), which he considers demonstrates that all salt which is taken by the mouth passes first into the tissues and thence into the blood. In fever this second passage is, he supposes, prevented owing to the high osmotic tension in the circulating fluids. In favour of the presence of increased osmotic tension of the blood in fever he quotes the analysis of von Stejskal (59), who found a small increase in the percentage of salts during a short febrile attack, and he assumes that there is further a considerable increase in the urea therein. Lastly, in support of the latter assumption, he mentions the post-critical urea excretion which may occur. Hijmans van den Bergh attaches no importance to water in connection with this problem, except in so far as reduced excretion thereof by the kidneys may interfere with the functions of these organs. To this extent his theory has a great advantage over that of von Moraczewski, for, in fact, the

evidence that there is in fever any serious retention of water is, as I have shown, quite unconvincing. Nevertheless, while it is not disputed that gross renal inadequacy raises the osmotic tension of the blood, and while it is possible that very serious alteration in the latter might produce some such result as above suggested; what is not demonstrated by this author is, firstly, that there is in fever renal inadequacy sufficient to cause any serious effect, or, secondly, that the osmotic tension of the blood is, as a matter of fact, abnormally high in this condition. Moreover the work of Magnus does not seem to me at all to bear the interpretation put upon it, for salt only passes into the tissues when there is already excess of it in the blood, in fact it was into the blood that Magnus introduced his salt. As regards the matter of renal inadequacy I cannot allow that epicritical urea excretion is proof of this, rather it is more probable that what is then excreted was previously an indiffusible product of metabolism locked up in the tissues, which, only now passing into the blood, is converted into urea, and promptly excreted (see chapter on urea excretion). Further retention of chlorine occurs where there is neither albuminuria nor epicritical urea excretion, while even where the latter phenomenon is observable it is not necessarily followed by return of the urinary chloride.

As regards the osmotic tension in fever our author produces but a single figure bearing upon the matter, he found in the blood of a case of pneumonia $\Delta = -\cdot 55$, a figure which is practically the normal, that usually given being $-\cdot 56$. However, Korányi (60), who has paid special attention to this point, finds that the osmotic tension of the blood in febrile conditions is in general not increased but on the contrary reduced. To this rule there are, however, according to Korányi, two noteworthy exceptions: —Firstly, fevers complicated with dyspnœa, particularly pneumonia, and secondly, malarial fever; in both of these alike osmotic tension is increased. The former is a disease characterised above all others by the frequency with which

chlorides disappear entirely from the urine; the latter is the one febrile condition in which their excretion is quite notably increased. This result seems to be fatal to the theories of von Moraczewski and Hijmans van den Bergh alike, and indeed it seems to me improbable that, if in addition to toxæmia the febrile organism were to suffer such a serious disturbance of its normal osmotic relations as to prevent the ordinary interchange of salts between blood and tissues, the patient would ever survive this combination of disasters.

Next we have the theory of Noël Paton, Dunlop, and Macadam (29), namely, that chlorine is retained in direct combination with albumen, and not as sodium chloride. This is to me a very attractive theory, for such a chlor-albumen might have bacteriacidal properties comparable to those possessed by the gastric juice. Some evidence in its favour can be produced as follows.

It was shown long ago by Forster that the blood is extremely retentive of its salt, and that in conditions of salt starvation sodium chloride was extracted from the tissues to feed the blood. This fact formed, indeed, the foundation of Roberts's (61) treatment of gout by abstention from sodium chloride. It is true that Schenck (62) observed that when animals were deprived of salt there was a passage of it from the blood into the tissues, but this condition was not maintained. His results cannot be compared with those obtained in fever, for here the retention of chlorine increases steadily with the progress of the disease, and so far from being dependent on a salt-free diet, the more salt one gives the more is held back. Further, Picard (63) has failed to confirm these observations of Schenck, and finds the composition of the blood as to its salt uninfluenced by a diet rich or poor in chloride. Forster's work has recently been confirmed by Langlois and Richet (64). They show that, when dogs are bled repeatedly, the sodium chloride of the blood increases at the expense of that of the tissues, particularly if the last bleeding is delayed. The loss by the tissues is most

notable in the muscles. They find again that a diet very poor in salt exercises no appreciable effect on the blood but much on the tissues, even the brain, but especially the muscles suffering loss. The reduction of chlorine which can be thus produced in the various solid organs averages 10 per cent., and is not changed by large doses of sodium phosphates. No increase in the blood or tissues results from a diet rich in salt, so that the result obtained by Magnus and Sollmann, by injection of salt solution into the circulation, do not allow of the conclusion arrived at by Hijmans Van den Bergh, as to salt taken by the mouth. Again, Biernacki (65) has shown that in man the blood is remarkably constant in its salt percentage, nor was this disturbed by repeated losses of hydrochloric acid due to chronic vomiting, which were not always attended by diminution of the urinary chloride. He considers that a poverty of the body as a whole in chloride does not influence the composition of the blood.

Now there is much evidence that the blood in pneumonia and, indeed, in other fever contains less sodium chloride than does normal blood. Thus Becquerel and Rodier (66), as a result of many analyses, found on an average in cases of pneumonia 2·8 per cent. of sodium chloride in the ash, in ephemeral fevers 2·7 per cent., and in typhoid 2·9 per cent., as compared with 3·0 per cent. in normal blood, although water was generally in slight excess in the febrile samples. On the other hand, more salt was found in cases of phthisis and rheumatism. Jarisch (67) found 2·86 per cent. in pneumonia, and 3·07 per cent. as an average for normal blood, water being the same in both. It is noteworthy that the pneumonia sample contained on the other hand more soda, 2·61 per cent. as against 2·41. Schenck (62) found, in a case of pneumonia, ·314 per cent. by weight in the fresh blood of the acute stage, and ·384 in convalescence ten days later, when chlorides were being excreted freely. Biernacki (65) found in fresh blood of pneumonia ·385 per cent.,

and ·455 per cent. in normal blood. In a case, however, when the blood was obtained by cupping this difference did not appear. Von Limbeck (68) quotes the following for the percentage by volume of sodium chloride; in pneumonia ·39, ·39, and ·422, in erysipelas; ·39, ·455, and ·455, in typhoid ·401 and ·548, only one of these coming up to the standard of normal blood, *i. e.* about ·460. Von Moraczewski (32, *c*) gives the chlorine found in 100 grams. of fresh blood in eight cases of pneumonia and one of typhoid; the average for the former is ·256 g., while ·243 g. was found in the latter. Schmidt (69) found ·262 per cent. in normal blood, and von Moraczewski (32, *a*), in another paper, gives yet higher figures for this, their average being ·276 per cent. Runeberg (48), in forty-four inflammatory serous effusions, found on an average ·65 per cent. of sodium chloride, these patients were probably febrile; in forty-one non-inflammatory sera he found an average of ·70 per cent., and in two cases of pneumonia ·60 and ·58 per cent. He further showed that these sera are a reliable index of the salt composition of the blood serum. Hutchison (31) found an average of ·67 per cent. in non-inflammatory effusions, and but ·52 per cent. in effusions accompanying pneumonia. Laudenheimer (54) again found only ·58 per cent. of NaCl in the serum of a case of this disease. Ritter von Stejskal (59) also found that a rise in temperature produced diminution of chlorine in the blood, the figures being ·236 per cent. by weight without, and ·226 per cent. with fever.

It is, therefore, clearly established, and indeed acknowledged by Hutchison, von Moraczewski, and Hijmans van den Bergh that the blood in fever, whether or no it contains more water, contains distinctly less sodium chloride than does normal blood. The conclusions suggested is certainly that in fevers the tissues generally *are not richer in sodium chloride than they are in health, but poorer, and probably notably so,* and this would seem both to confirm the opinion of Noël Paton and account

for the salt hunger previously mentioned. Chlor-albumens free from sodium have, in fact, been prepared by Mulder in 1840; they, as well as other haloid-proteid derivatives, have been used therapeutically by Blum (70), and they have been purified and analysed by Hopkins and Brook (71). Moreover, it has been shown by Hamberger (72) and others that the blood-cells, both red and white, are readily permeable to chlorine and other electronegative ions dissociated from sodium, so that the two are easily separated. Indeed, the corpuscles may, as Hamberger suggests, act as carriers of dissociated acid ions from the tissues. Nevertheless, evidence of the presence in the tissues of free or organically combined chlorine is lacking, and the loss of salt might be equally attained if inorganic chlorides were stored in some single organ, or chlorine were lost in some form and manner not hitherto suspected. Examination of the tissues themselves is necessary. Of such analyses I find but two series in the literature, excluding those conducted on pneumonic lung; they are those of von Moraczewski (32, *e*) and Hutchison (31), and a comparison of the two yields unexpected results. I will take Hutchison's first. His method was to cut the tissue in thin slices, squeeze out all the blood as far as possible, dry at 110°, and then heat with lime in a long combustion tube. Chlorine was then estimated in a nitric acid solution of the contents of the tube. This method is one employed for chlorine analysis in organic combination; there would be no risk of loss of sodium chloride, nor of organic chlorine, unless it were during the preliminary drying. Hopkins' chlor-albumens are, however, decomposed by drying at 100°.

His results are these:

	Per cent. of water.	Per cent. of Cl in dry substance.
Muscle (biceps) from a case of apoplexy .	58	... ·170
„ „ „ carcinoma.	75	... ·130

The second result is interesting as showing that the more watery tissue contained less chloride, but a case of

carcinoma can hardly be regarded as normal. Disregarding this sample, we have in the fresh normal muscle ·071 per cent. of chlorine, a figure which agrees well with that of Katz (73), who finds ·070 per cent. in the fresh human muscle, and of Bunge (74, *a*), who finds the same quantity in fresh muscle of ox. This is also the figure accepted by von Moraczewski for normal muscle.

The average result in three cases of pneumonia was as follows:

	Per cent. of water.	Per cent. of Cl in fresh substance.	Per cent. of Cl in dry substance.
Muscle (biceps)	77·4	·037	·163

The quantity of chlorine in fresh muscle of pneumonic patients is thus found by Hutchison to be only about the half of that found in normal muscle. The reduction in the chloride is therefore extremely striking. In taking the fresh substance and not the dried as a standard of comparison I am adopting the recommendation of von Moraczewski, who points out that the latter is very unreliable. Hutchison himself used the dry substance as a standard, arriving thereby at a different conclusion to that given above. His figures represent sodium chloride, but I have converted them for convenience of comparison, so as to represent chlorine.

Passing now to the liver, we find four cases from pneumonia and three from other febrile diseases, phthisis, typhoid, and tuberculosis.

	Per cent. of water.	Per cent of Cl in fresh substance.	Per cent. in dry.
Average in pneumonia	75·9	·119	·50
In other febrile conditions	78·0	·110	·48
Average of all febrile conditions	76·8	·115	·49
Case of fatty heart	71·3	·272	·95

Here again the gland of the afebrile patient is notably richer in sodium chloride. I do not, however, wish to emphasise this, because the figure given is abnormally high. The only other sample investigated was from a case of unknown disease, so that I cannot class it. Turning now to von Moraczewski's results, and selecting

those which can be compared with Hutchison's, we find the following:

Heart muscle of pneumonia—

	Per cent. of water.	Per cent. of Cl in fresh substance.	Per cent. in dry.
1 . .	83·1 ...	·142 ...	·82
2 . .	85·4 ...	·319 ...	2·18
Average .	84·2 ...	·230 ...	1·50

Whereas Hutchison finds in fresh muscle ·037 per cent. of Cl, or about half the normal quantity, von Moraczewski obtains ·230 per cent., or more than three times the normal, and more than six times as much as Hutchison. Moreover, the difference between his own two results is remarkable. Von Moraczewski further finds:

In liver of pneumonia—

	Per cent. of water.	Per cent. of Cl in fresh substance.	Per cent. in dry.
1 . .	65·9 ...	·092 ...	·29
2 . .	88·3 ...	·217 ...	1·85
Average .	77·1 ...	·154 ...	1·07

The difference here between Hutchison's and von Moraczewski's figures is much less, ·115 per cent. against ·154 in the fresh organ. It is noteworthy that Hutchison used skeletal muscle and von Moraczewski that of the heart. This might cause a difference not observable when both used liver, and I shall presently show grounds for concluding that this supposition is correct. Also the latter made no attempt to remove superfluous blood, and he conducted his analysis on fresh tissue in the wet way with nitric acid and silver nitrate, so that the samples were never heated. Can this explain the different results obtained?

The only other analyses bearing on the subject beyond those of the authors quoted are those of Achard and Loeper. They gave 10 g. of salt to each of a number of patients suffering from febrile and afebrile complaints, including heart disease and chronic nephritis, and found that rarely was more than 3 g. excreted in twenty-four hours; further, that the immediate effect was to increase

the chloride of the blood and serous effusions if these were present. After death extraordinary quantities of salt were found in the muscles and brains of uræmic patients, and the authors conclude that in all cases where chlorine is retained this accumulation occurs. I do not, however, gather from their paper that they have examined the tissues of febrile cases with the exception of the lung in pneumonia, and, inasmuch as it is generally acknowledged that there is retention of water in renal disease, and yet the osmotic tension of the blood is high, conclusions drawn from these cases cannot unreservedly be applied to conditions of fever, where there is little, if any, retention of water, and yet the osmotic tension of the blood is low.[1]

I have myself carried out a limited number of analyses, choosing the heart muscle on account of the strange difference between the results of von Moraczewski on this tissue as compared with those of Hutchison on skeletal muscle. I have not neglected to compare febrile muscle with normal from the same organ, using the same method for each, and in each case removing superfluous blood, also I have at the same time endeavoured to ascertain if organic chlorine were present in the following way.

Author's results.—The muscle (left ventricle) was passed several times through a mincing machine, and then small and approximately equal masses of the product were wrung out in muslin to remove blood, until all had been subjected to this process. Portions were then weighed out in glass capsules with ground-on lids, and these were subsequently placed open in a Muller's rapid dessicator, which was then exhausted with the air pump until the manometer registered about 4 cms. of Hg. After two or three days the samples were reduced to powder, thoroughly mixed, returned to the capsules, and dried to constant weight, a proceeding which took from five to seven or more days. The loss of weight gave the contained water already

[1] I have since obtained a paper by Baylac (92), which adds point to my criticism. Using tissues from cases of pneumonia, he tried to confirm the results of Achard and Loeper, but failed to do so.

referred to. The dried matter is very hygroscopic, so that the lids of the capsules must be replaced immediately after removal from the desiccator. The powder was then rapidly transferred to a stoppered tube, whence it was weighed out into long-necked Kjeldahl's flasks or platinum dishes for analysis as follows.

In the first series samples of two grams or more were taken in two flasks, one of which was then heated at 140° C. in the air bath for six hours or longer. To each was then added nitrate of silver solution (1 c.c. = ·01 Cl), 2·5 c.c. to a gram of the powder, then 30 c.c. of nitric acid of sp. gr. 1·50, and they were left to stand in the cold until most of the organic matter was dissolved. They were then heated in the water bath, starting at 70° and rising to 100°, and finally on the sand bath. They were kept boiling, exactly as in Kjeldahl's process, only for a very much longer time, until the fluid was reduced to a few c.c., then another 10 c.c. of acid were added, and the process repeated. Finally 20 c.c. of distilled water were poured in, the liquid boiled for a few minutes, then washed out into a 150 c.c. flask, made up to the mark when cold, filtered, and 120 c.c. of the filtrate titrated with ammonia thiocyanate. This process, which is that of von Moraczewski with but a slight modification, is simple, but the boiling off of the nitric acid is extremely tedious, and probably accompanied by some risk of loss of silver nitrate, causing an excess of chlorine to appear in the final result. To obviate this as far as possible I placed loosely-fitting stoppers in the mouths of the flasks, nevertheless my results show decided differences, probably due to experimental error. It must be remembered that the quantities of chlorine dealt with are very small, and a very moderate absolute loss of silver nitrate would cause a large percentage increase of chlorine. In the second series only half the quantity of silver nitrate was used. All the samples are heart muscle unless otherwise stated.

	Per cent. of water.		Per cent. of Cl in fresh substance.		Per cent. of Cl in dry substance.
1. Bullock, normal . .	76·90	Not heated	·105	...	·456
2. Normal child, aged 4, killed by accident . . .	78·91	Not heated	·134	...	·634
		Heated	·129	...	·614
3. Febrile adult, acute rheumatism	80·53	Not heated	·084	...	·432
		Heated	·081	...	·416
4. Febrile adult, typhoid, with septic complications .	80·07	Not heated	·144	...	·724
		Heated	·136	...	·680
5. Febrile adult, pneumonia, with pericarditis . .	80·22	Not heated	·100	...	·504
		Heated	·105	...	·531

Average for normal fresh muscle, unheated, ·119 per cent., for febrile ·109 per cent. Cl. From these results it appears that heart muscle contains, as a rule, decidedly more chlorine than does skeletal muscle, and that the difference between febrile and afebrile muscle in this respect is not necessarily in favour of the former. Further, that the lack of correspondence between Hutchison's and von Moraczewski's results is not due to drying of the tissue by the first named, and finally that there is no evidence of the presence of organic chlorine decomposible at 140° C. To further investigate this question of organic chlorine, in the next series one sample of the substance, dried as before, was analysed by von Moraczewski's method without previous heating, another was placed in a platinum dish with 15 c.c. of lime water, evaporated, dried, ignited till black, extracted with dilute nitric acid, the residue re-ignited and extracted, and the filtered solution analysed for chlorine by Volhard's method.

	Per cent. of water.		Per cent. of Cl in fresh substance.		Per cent. of Cl in dry substance.
1. Normal adult, aged 45, died three hours after railway accident .	78·92	Not heated	(1) ·080	...	(1) ·380
			(2) ·081	...	(2) ·385
		Ignited	(1) ·069	...	(1) ·329
			(2) ·071	...	(2) ·335
2. Normal adult, aged 72, killed by an omnibus	76·11	Not heated	·108	...	·451
		Ignited	·101	...	·424
3. Febrile child, aged 4, toxic scarlet fever .	78·72	Not heated	·102	...	·481
		Ignited	·090	...	·423
4. Febrile adult, pneumonia uncomplicated .	78·44	Not heated	·101	...	·468
		Ignited	Lost	...	Lost
5. Liver of No. 4 . .	75·69	Not heated	·079	...	·325
		Ignited	·081	...	·335

There is a constant excess by von Moraczewski's method, except in the case of the liver, possibly the formation of some cyanide during ignition may account for the difference here. Again, there is no evidence of excess of chlorine, organic or other, in the febrile as compared with the afebrile tissue. These figures confirm neither the theory of von Moraczewski nor that of Noël Paton, but a study of other tissues might yield results of more interest.

Some time previously I carried out an analysis with the view to ascertaining whether chlorine was retained in organic combination in the blood during fever. The blood used was that of a horse, and was obtained through the kindness of Dr. Todd of the "Jenner Institute of Preventive Medicine." It was dried *in vacuo* over sulphuric acid, and the chlorine estimated by ignition with sodium carbonate, and subsequent weighing of the chlorine as chloride of silver, and also by the latter proceeding after prolonged heating in sealed tubes with nitric acid and silver nitrate after the method of Carius.

Blood obtained during the period of reaction after a dose of virulent streptococci:

	Per cent. of Cl in fresh blood.		Per cent. of Cl in dry substance.
1. By ignition	·267	...	1·65
2. By Carius' method . . .	·256	...	1·58

The ignition yielded the higher result, possibly due to the formation of cyanides. Katz has found that there is considerable risk of this when ignition with sodium carbonate is practised. Here again I find neither excess of chlorine nor evidence of it in organic form. The method of Carius is, however, unsatisfactory for blood, there is too much organic matter and too little chlorine, and several tubes burst; von Moraczewski had a similar experience with this process.

Hutchison's suggestion as to the cause of retention of chlorine is that the increased metabolism of fever necessitates somehow the presence of abundance of sodium chloride, and he points out that both increased metabolism

and retention of chlorine result from carbonic acid poisoning. I cannot, however, allow that he has demonstrated that the tissues in fever do, as a matter of fact, contain excess of sodium chloride, but rather the contrary.

Finally, there is Sollmann's explanation which I have already mentioned—namely, that there is nothing in any way specific about the behaviour of chlorine in fever. It is merely due to salt starvation. The fatal objection to this idea is, that *while absolute and prolonged starvation in man never causes complete disappearance of the chlorides from the urine, fever does so frequently, and that in a few days, in spite of the ingestion of salt.* In fact, none of these hypotheses have yet been proven.[1]

Further work on this subject is necessary, and the success of Noël Paton, Dunlop, and Macadam in producing chlorine retention in dogs indicates the line along which fruitful research might proceed. I would suggest that future workers start unbiassed by previous opinions, and do not assume that the chlorine is necessarily retained in combination with sodium, or even in the same part of the body. It is possible that the two serve quite different purposes and in different places. Dr. Newton Pitt has pointed out to me the importance of not neglecting the bone marrow in carrying out a general analysis of tissues.

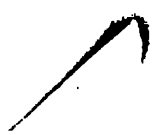
Returning now to the sodium, I have already brought forward, when dealing with the relation of sodium to chlorine, evidence that some of the sodium may be retained independently of chlorine and probably for a different purpose. To this matter I will now return.

The cause of the retention of sodium alone.—Forster (47) found that when animals were fed on a diet almost free from

[1] Since this thesis was written a further paper by Sollmann (93) has appeared, in which evidence is brought forward in favour of the theory of Forster as accepted by Röhmann. He concludes that when chlorides are not excreted by the kidneys it is because the "unbound chlorides" of the blood serum are reduced in amount. This conclusion is based on experimental work upon afebrile animals, and has no special reference to the febrile state.

salt they died more rapidly than animals wholly deprived of nourishment; the animals used were pigeons and dogs. The explanation offered by Bunge (74, *b*) for this anomaly is that the sulphur of the proteid given, being as usual oxidised to sulphuric acid, but having in the food no bases with which it could combine, seized upon bases which were integral parts of the living tissues, and hence the above result. Experiments carried out by Lunin (75) with mice confirm this explanation, for those fed on salt-free food, to which was added sufficient sodium or potassium carbonate to yield one equivalent of the base to one of sulphur, lived on an average double as long as those to whose salt-free food no addition was made, or only the chloride of sodium or potassium added. These experiments suggest that in the above animals the fixed bases and not ammonia are concerned in regulating alkalinity, and von Limbeck has recently brought forward evidence that man in this respect resembles the herbivora rather than the carnivora. This matter will be further discussed in connection with ammonia excretion. It seems, therefore, not unlikely that some retention of bases is connected with the increased production of acids in fever, and the fact that sodium is the base selected suggests that it must be sought in the blood and not in the tissues. That the total alkalinity of the blood rises, or at any rate makes an effort to do so, as the result of infection has been shown by much recent work to which I will now allude.

Modern work on the alkalinity of the blood may be said to date from the discovery by Löwy (76) that the total alkalinity is the only alkalinity which can be estimated satisfactorily, and is quite distinct from that of the plasma. He used blood in which clotting was prevented by addition of ammonium oxalate, and the corpuscles were broken up by free dilution, he then titrated it directly. Many modifications of his process have been introduced, but the essential feature, the estimation of the total alkalinity, that is of plasma and corpuscles, is usually preserved by modern workers. Löwy found that this total alkalinity was not necessarily reduced in fever, but might be considerably increased. Again in conjunction with Richter (77) he found that the total alkalinity is in animals increased when fever is artificially produced by infective agents and certain organic poisons, but not by brain puncture. These authors regarded augmented alkalescence of the blood as a definite reaction to the



combined stimulus of infection and pyrexia. Previous to this discovery von Foder (78) had shown that the bacteriacidal properties of the blood outside the body were increased by the addition of alkalies, particularly alkaline carbonates, though diminished by quinine and tartaric acid. They were also increased by moderate heating. Further, animals into which solutions of sodium bicarbonate had been injected were notably more resistant to anthrax than were control animals. The literature since these earlier papers has grown so extensive that to quote from it would occupy too much space. I would therefore refer readers to a paper by von Rigler (79), where many summaries of previous work and references are given; also to those of von Limbeck and Steindler (80), Strauss (81), Karfunkel (82), and Brandenburg (83, 84), the last being the most recent, and containing therefore summaries of others not mentioned above. It seems to be clearly established that toxines, especially in lethal doses, depress alkalinity; and antitoxines have the converse effect; also that depressed alkalinity implies diminished resistance to infection and *vice versâ*.

My study of this literature, so far as I have been able to carry it, leaves a very definite impression that the effort of the organism in response to invasion is to raise the alkalinity of its blood, in spite of increased production of acids, and that the more it succeeds in this endeavour the more likely it is to survive. It seems also not improbable that it does so by combining an alkali, presumably sodium, with albumen, though whether or no this albumen is an integral part of any corpuscle is not definitely ascertained; further that this alkali serves a useful function in resisting disease, though whether in virtue of its anti-acid powers or of anti-bacterial properties of the alkali itself, or in some indirect way, is not certain. Perhaps also it is stored in indiffusible form, and converted into diffusible as required. As a practical result of my study of this matter I have been in the habit of prescribing sodium citrate in doses of twenty to thirty grains every four hours for an adult, as a remedy for acute scarlet fever. With a little lemon and plain or aërated water it

makes rather a pleasant drink, and it is unlikely to do harm, which is more than can be said of many remedial measures. The death-rate from this disease is, however, so low under any circumstances that I am unable to express any opinion as to the effects of the treatment except that it is worthy of a more extended trial. In addition I usually add small quantities of salt to the milk. I may state that Graves (85), of Dublin, in 1836, and indeed others long before him advocated the use of sodium chloride in fever, and that Parkes (14, *a*) recommended alkalies, particularly salts of sodium in 1855. Of modern writers von Moraczewski and Sollmann have recently advocated large doses of sodium chloride in the treatment of fever, and Burney Yeo (86) has recommended alkalies. Again Huchard (87) has recommended vigorous administration of sodium chloride in chronic diseases where marked hypochloruria is found. He regards the latter as of grave prognostic importance in such cases, and quotes Méhu in support of this unfavourable opinion.[1]

Before concluding this topic I must allude to a phenomenon observed by von Moraczewski which is put forward by C. A. Herter as absolute demonstration of the truth of the theories of the former as to the nature of chlorine retention. I have reserved it till now because it concerns also the excretion of phosphoric acid to which I shall pass presently, and the anomalous behaviour of chlorine and sodium in malaria which I have to deal with next. Von Moraczewski finds that while the relation of phosphorus to nitrogen in the food is about 1 : 5—10, in the excretions of pneumonic patients it is but 1 : 10—20 ; if now large doses of sodium chloride are given the relation rises to that in the food or even higher. It is argued that the sodium chloride usually retained is insufficient to saturate the watery tissues, and hence phosphate is sucked in by

[1] On the other hand, Widal and Lemierre (94) have recently found that there is risk of producing œdema in renal cases if salt is given, and Castaïgne and Rathery (95) that salt excess or starvation alike is injurious to the kidney. For details their papers must be consulted.

them in addition; while if more sodium chloride be given this more active salt replaces the phosphate, which is then duly excreted. To this explanation there are many objections, not the least of which are the absence of evidence that the tissues in fever are really seriously watery, and the fact that von Moraczewski himself insists that the blood in fever is, like the urine, rich in phosphorus, while the tissues are unusually poor therein. Increase of phosphorus in the blood in fever and inflammatory conditions was found also many years ago by Becquerel and Rodier. Further a study of von Moraczewski's figures reveals that moderate doses of sodium chloride, such as five grams daily, which caused no increased excretion of nitrogen, had no effect upon that of phosphorus either; not only so, but that phosphates taken simultaneously were retained in the body, even though a free excretion of chlorine indicated that the sodium chloride was in excess of its needs. Lastly the large absolute and relative excretion of phosphorus in cases treated with larger doses of salt began to occur only when the temperature fell, or shortly before this. The explanation which seems to me the most simple and probable is that the large doses of salt promoted the metabolism both of organic nitrogen and organic phosphorus, including the large store of nucleoproteids rich in phosphorus, contained up to this time in the pulmonary exudate; further that this effect was produced more readily after the crisis, when any excess of water had been eliminated, and the tissues were in all probability unusually dry. I would repeat here that Hatcher and Sollmann have found that in typhoid fever large doses of salt promote the metabolism both of nitrogen and phosphorus, and further that unusual dryness of the tissues was found by Straub to have the same effect. It does not seem to me that this phenomenon throws any light on the nature of chlorine retention, or that it affords confirmation of the theories of von Moraczewski.

Chlor-metabolism in malaria.—It remains now to discuss the anomalous behaviour of chlorine and sodium in

malaria, and malaria only. There we have no retention of water, of sodium, or of chlorine, but a large increase in the excretion of all these, as well as of potassium, ammonium, and urea; yet a remarkable retention of phosphoric acid, which, even when given as sodium phosphate, is not excreted till the temperature falls. The explanation of this anomaly offered by Terray (26) is, that the sodium chloride comes from the red-blood cells destroyed, but he offers no suggestion as to why phosphoric acid is retained. Such a holocaust of red cells, as would lead to a reversal of the ordinary phenomena of fever would surely be incompatible with life, and this theory has been rejected by Hitzig (88), von Moraczewski (32), von Limbeck (89), and Hutchison (31). Von Limbeck is at pains to calculate how much sodium chloride might, in point of fact, be produced in this way in an average attack of ague, he reckons that each red corpuscle contains ·00000000025 mgrms. of NaCl, and that the total yield would be about ·2 g., while that excreted may amount to 1·8 g. per hour, though very little reduction takes place in the number of red cells. Again, Hutchison finds no increased excretion of chlorine in paroxysmal hæmoglobinuria. Von Moraczewski's explanation is, that at the beginning of every fever, either as the result of vasomotor constriction or of retardation of the blood-stream, an arrest of the normal interchanges between blood and tissue occurs, and that the former, in consequence, gives up to the latter less chlorine and receives less phosphorus, hence more of the former and less of the latter appears in the urine. There is, therefore, according to him, no difference between malaria and other fevers in this respect, provided you study the latter sufficiently early. As regards the behaviour of phosphorus some support is given to this theory by the observation of Freund (90,), who found phosphoric acid absent from the urine at the commencement of an attack of pneumonia and of tonsillitis, as well as in malaria. With respect, however, to chlorine it is generally acknowledged that its behaviour in malaria is

unique, and the chief evidence in support of his theory, brought forward by Moraczewski, is an insignificant rise in the excretion of chlorine to but ·24 g. per hour, with the rise of temperature, in a case of phthisis with hectic fever; with a similar rise the next day chlorine excretion fell, and but two days are recorded. Further it seems to me probable that the circulation in the internal organs including the muscles, is more and not less active at the commencement of the fever, and that the interchange between blood and tissues is then more rapid rather than arrested; again, though this view is not held by von Moraczewski, that the early rise in urea excretion, demonstrated in this disease by Ringer, which may precede the rise of temperature, favours the above assumption.

Von Limbeck suggested that the chlorides are excreted because the phosphates are retained, the one replaces the other. He quoted as a converse occurrence the increased excretion of alkaline carbonates which follows on taking large doses of salt. The absence of increased excretion of chlorine in other fevers where retention of phosphorus may occur he attributed to loss of chloride in the exudate. One objection to this theory is the absence of evidence that phosphates can replace chlorides. Langlois and Richet, who have tried the experiment upon animals, have found that sodium phosphate cannot replace sodium chloride in the blood or tissues. Again retention of chloride is quite independent of exudation. In any case he but shifts our inquiry from "Why are chlorides excreted?" to "Why are phosphates retained?"

Hitzig points out that certain poisons such as toluylendiamin, which destroy red blood-corpuscles, also disturb chlor-metabolism, as Kast (91) has demonstrated, for they produce excretion of chloride far in excess of any that could come from the red cells. He suggests that malarial toxine possesses not only the destructive action aforesaid, but also the property of disturbing chlor-metabolism manifested by the above poison; in favour of this supposition is the fact which he observes that there is

more chlorine in the blood during the fever than there is subsequently. It must, however, be mentioned that Korányi has obtained different results, namely, a reduced percentage at the height of the fever, with increase later. Hutchison attributes the behaviour of the chlorides merely to diuresis. I think he is probably right in the main, but at the same time in other fevers, as I have shown, diuresis produces no such effect. The explanation I would offer is that malaria being a blood disease and not of bacterial origin the protective mechanism is different, and chloride is, therefore, not required, so that the organism does not store it or use it. Hence diuresis produces its normal effect. Possibly also some special action of the malaria poison, as suggested by Hitzig, assists the influence of diuresis. The cause of the retention of phosphorus will be considered in discussing this excretion.

Conclusions.—1. The cause of the retention of chlorine in fever is quite unknown, nor is it certain in what combination or situation it is stored, or even if it is stored at all, and does not leave the body in some form, and by some route not hitherto suspected.

2. There is little evidence that the retention of chlorine is directly connected with retention of water.

3. There is some evidence that small quantities of sodium may be retained, not as chloride, but in some alkaline form, or combined with the acids of metabolism.

4. The anomalous behaviour of chlorine in malaria as compared with bacterial toxæmias is perhaps due in part to the essentially different nature of the infective agent, and suggests that chlorine retention is a result rather of bacterial toxæmia than of pyrexia, and may be protective.

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Part III.—On the Metabolism of the Solid Tissues and the Excretion of their Products.

The Excretion of Urea.

Physiological variations.—The excretion of urea in health depends mainly on the diet, an ordinary adult on mixed food producing about 21·5—34 g. in twenty-four hours, 84—90 per cent. of the total nitrogen being in this form (Huppert, 1). On a diet of 1832 g. of beef and 70 g. of fat, Ranke (2) found 40·93 g. of nitrogen excreted, yet the man lost weight consider-

ably. Recently Goodbody, Bardswell, and Chapman (3) have found it possible, by greatly augmenting a mixed diet, to cause temporary gain in weight but disturbance of health. The excretion of nitrogen by the urine was nearly doubled, and but little was lost by the fæces, but the fats were imperfectly absorbed. On the other hand, in inanition the excretion of nitrogen may fall to 3 g. daily (Huppert). It is indeed remarkable what extraordinary variations in the combustion of proteids are consistent with the preservation of an almost normal temperature, in spite of the fact, observed by Rübner (4), that the body is very economical in the use of its fuel, and practically the same amount of heat is produced by combustion of food within it, as inside a Thompson's calorimeter. That the usually comparatively moderate combustion of proteids in fever would raise the temperature if the regulating mechanism were working normally is therefore extremely unlikely.

The effects of fever.—That the percentage of urea is increased in the urine of febrile patients was noticed by Prout (5) in 1825; he, however, attributed this entirely to concentration. Simon (6), in 1842, stated that urea was increased in inflammatory conditions, also sometimes in fevers, and he quotes other authorities.

Little progress was made, however, until the introduction by Liebig, in 1853, of a comparatively simple volumetric method of estimation initiated quantitative analysis as a matter of routine. Among the earliest workers with Liebig's method must be mentioned Alfred Vogel (7), in 1854, and Traube and Jochmann (8), and Parkes (9), in 1855. Vogel and Parkes studied various fevers, Traube and Jochmann malaria only. The first named found increased excretion of urea in all his febrile cases, the largest output recorded being 80 g. in a case of pyæmia. Parkes found, as a rule, an increase, but sometimes a diminution which he attributed to retention.

Traube and Jochmann found a direct correspondence between urea and temperature: a point that was demonstrated yet more clearly, also in a case of ague, by Sidney Ringer (10). The latter was the first to show that the

rise in urea excretion may precede that of the temperature; a point subsequently confirmed by Naunyn, and also Senator in experiments on animals. Again, Moos, Brattler, Warneke, and Parkes showed that in typhoid fever the correspondence between temperature and urea excretion was fairly close. Huppert (11), indeed, maintained that in fevers generally the more frequently the temperature was taken the closer this relation would appear. On the other hand Squarey (12), at the London Fever Hospital, and Rosenstein (13), abroad, showed that this rule did not apply to typhus fever, Riesenfeld (14) and others found that in relapsing fever the largest excretion might follow the crisis, and Unruh (15) found the same to occur in pneumonia, an observation that has been frequently confirmed; he showed, moreover, that in other fevers it was exceptional to obtain the highest excretion early in the disease however high the temperature. In severe cases of typhus a fall in urea is not uncommon in the second week, though the temperature remain high. This has been attributed to imperfect elimination of nitrogen, or imperfect absorption of food. Malnutrition may, in fact, in any fever, especially if it is prolonged, reduce the excretion of urea (Cohnheim [16]). Recently certain additions have been made to our knowledge of this subject. Thus May (17) has shown that, in rabbits deprived of food and water, the increased excretion of nitrogen resulting from inoculation with swine erysipelas can, by administration of sugar, be reduced to that produced by inanition without fever. The excretion does not, however, fall to that without fever, and with the use of sugar. May did not try the effect of albuminous food. Von Moraczewski (18), working on patients with pneumonia, found the output of nitrogen to vary widely, and that there was nearly always a large post-critical rise. He found that the excretion did not, as in health, vary with the diet, for, on a nitrogen free diet—namely, sugar—it reached 20 g., while on a diet rich in nitrogen it might be low. As regards the nitrogen balance, administration of sugar, or

of moderate doses of sodium chloride, reduced the loss of nitrogen. Moreover, the same effect was produced, both during the fever and in convalescence, by use of a diet rich in nitrogen. Further, such a diet, as also the addition of moderate doses of salt, appeared to have a beneficial effect, which was not apparent when sugar was added. I may mention in this connection that de Campnolle (19) has shown that sugar is not at all well tolerated by febrile patients, it readily induces vomiting, and a much smaller quantity suffices to produce glycosuria in them than in normal persons. Hale White (20) draws from May's results the conclusion that it is desirable to give carbohydrates in fever. Liebermeister (21) was also a strong advocate for their use, he regarded milk as of less importance, and disapproved of highly nitrogenous food. Von Moraczewski's results point to the latter being superior, and he recommends it. An interesting analogy to this effect found by von Moraczewski on the nitrogen balance when nitrogenous food was given appears in the work of Cario (22). This observer obtained the same result by rectal feeding in cases of carcinomatous obstruction of the œsophagus provided cachexia was not too advanced. The objection to nitrogenous food is of very old date, and seems to have rested originally on the assumption that fevers were inflammatory in their nature, and required for their treatment methods of depletion. Graves, of Dublin, was one of the earliest to oppose this doctrine, and he found a strong supporter in Stokes (23). In this connection I may perhaps be allowed to quote a story told by the latter in his admirable clinical lectures. A lady lay so ill with typhus fever that her life was despaired of. Her sister, in response, to what she considered a last request, brought to the bedside a large mess of beef and cabbage smoking hot, which the patient devoured with great avidity. Her husband returning shortly after was terrified, he sent for doctors in every direction, and four or five assembled. All agreed that some extraordinary effort must immediately be made to remove from the lady's

stomach this mass of food. While, however, they debated Dr. Harvey arrived, and was hurried to the bedside by the anxious husband. Finding the patient asleep he said, "I should wait till she wakes, let her sleep it off." She did so, awaked wonderfully better, and was soon out of danger. F. Hirschfield (24) has found it possible to keep phthisical patients in a condition of nitrogen equilibrium for weeks, in spite of a temperature of 37° to 39·5°, by use of a mixed diet yielding 40—50 calories per kilo. of body weight. It was essential that the patient should preserve his appetite in order to obtain this result. Equilibrium could not be maintained during the period of reaction to tuberculin. Again, S. Weber (25) has found it possible, by considerably increasing the food, not only to prevent loss of nitrogen by sheep during fever, but even to secure a gain of nitrogen to the body. This was achieved whether albuminous or carbohydrate food were in excess. He found that increased consumption of albumen could not be altogether prevented by merely increasing the carbohydrate, but that loss to the body might be avoided by increasing both foods. The agent used for inducing fever was glanders toxine, which produced a high temperature without seriously interfering with the appetite of the animal.

The reported effects of antipyretic treatment on the excretion of nitrogen are contradictory. Riess (26) has found that in typhoid fever, if the temperature is reduced by large doses of antipyrin, the excretion falls, whereas, if the same result is produced by continuous cold bath treatment, the contrary occurs. The latter result may have been partly due to diuresis. Authorities are not, however, agreed upon these matters, and conflicting results are quoted by Riess in his paper.

Author's results.—Turning now to my own work, the accurate estimation of urea involves so much labour that I have only occasionally undertaken it. In a few cases I have estimated the total nitrogen, but I have found it impossible to continue the practice. Therefore in the

great majority of cases the hypobromite process has been used, the nitrogen being collected in an accurately graduated Lunge nitrometer, corrected for temperature, etc., and the urea calculated by Hüfners formula (urea g. 1 = 354·33 c.c. of N. at 0° and 760 mm). *The inaccuracies introduced by ammonia and extractives have therefore been neglected, so that my results are always too high.*

I have collected a number of these figures and arranged them in seven groups, of which the first six represent samples from patients on a milk diet, with one egg and occasionally a little milk pudding or custard when the temperature fell; the seventh, samples during the first day or two after the change to fish or meat diet.

Twenty-four hourly excretions of urea in grams.

A. *Cases of scarlet fever.*

Groups.	No. of samples.	Maximum.	Minimum.	Average.
1. Temp. of 103° or over	20	40·79	11·80	32·15
2. „ 102°—103°	12	53·76	20·90	33·46
3. „ 101°—102°	20	66·60	25·21	41·39
4. „ 100°—101°	16	85·50	27·54	45·92
5. „ 99°—100°	9	48·40	13·90	34·46
6. „ below 99°	7	33·47	21·65	27·63
7. On fish or meat diet	22	52·80	10·76	31·47

Average of sixty-eight samples for temperatures of or over 100° and on milk diet 38·34.

Average of sixteen samples for temperatures under 100° and on a milk diet 31·47.

B. *Cases of morbilli.*

Groups.	No. of samples.	Maximum.	Minimum.	Average.
1. Temp. of 103° or over	6	55·20	22·95	34·81
2. „ 102°—103°	3	37·82	14·40	23·78
3. „ 101°– 102°	5	38·72	20·20	30·91
4. „ 100°—101°	3	32·85	18·50	24·46
5. „ 99°—100°	3	32·02	22·13	26·06
6. „ below 99°	11	38·70	13·95	25·52
7. On fish or meat diet	18	49·13	17·52	28·70

Average of seventeen samples for temperatures of or over 100° and on milk diet 29·89.

Average of fourteen samples for temperature under 100° and on milk diet 25·64.

c. *Cases of scarlet fever* (18), *morbilli* (10), *rubeola* (4), *and tonsillitis* (1) *together.*

Groups.	No. of samples.	Maximum.	Minimum.	Average.
1. Temp. of 103° or over	27	55·20	11·80	33·15
2. „ 102°—103°	15	53·76	14·40	31·52
3. „ 101°—102°	25	66·60	20·20	39·30
4. „ 100°—101°	22	85·50	18·50	42·61
5. „ 99°—100°	13	48·40	13·90	31·92
6. „ under 99°	21	40·63	13·95	27·50
7. On fish or meat diet	50	52·80	10·76	29·47

Average of eighty-nine samples for temperatures of or over 100° and on milk diet 36·94.

Average of thirty-four samples for temperatures under 100° on milk diet 29·19.

The average of the test cases on the same diet was 21·69, giving a ratio to the above of 1 : 1·70 and 1 : 1·34 respectively, but, as urea was estimated accurately in the test case, the figures for febrile cases are too high.

My results agree remarkably with those of Unruh, who found a ratio of 1·7 : 1 for fever, as compared with no fever on the same diet. The excretion of urea is thus notably increased, especially in scarlet fever. There is never any direct relation between temperature and this excretion; in morbilli it is irregular, and in scarlet fever it increases steadily with a falling temperature until 100° is reached; then falls, to rise again with change of diet. The largest excretion is not delayed until after the fall of temperature, as is commonly the case in relapsing fever and pneumonia, and sometimes in typhus. The fevers here considered seem therefore to occupy, in respect to their urea excretion, a position intermediate between those last named and typhoid fever and malaria. With regard to the excretion of urea in scarlet fever, statements have

been made by Ringer (27) and Gee (28) which would seem to place this disease in a class entirely by itself, as a fever in which increased excretion of urea is uncommon. By Ringer this conclusion was arrived at from comparison of the excretion during fever with that during the latter part of the stay in hospital, when the patient was taking ordinary food; by Gee from comparison with that on the diet of fever after the temperature had fallen. My results do not at all confirm these observations. Whereas, however, mine were adult, or nearly adult, cases, selected on account of high fever, theirs were children, not so selected. Now, a difference between the urea excretion of children and adults was noticed by Huppert (11); he found that, while in the latter a large excretion of urea after the temperature fell was rare, it was common in the former. He explained this by assuming that the relatively larger quantity of food taken by the young accentuated in them the influence of change of diet. This might explain Ringer's results, but not Gee's. It is possible, however, that there are dissimilarities between adults and children which are not due to diet, and hence the striking difference between my results and those of Gee. It is noteworthy that one of my eighteen scarlet fever cases, V. R. G., No. 12, produced no more urea than that normal for the diet, and he was younger than the others. His was, however, the only case of relapse investigated, and his excretions were abnormal in other respects. Unfortunately he was not weighed, but he was well grown for fifteen, and had a high temperature.

Absence of increase in the excretion of urea has been noticed by P. Reynard (29) in a case where fever was caused by inflammation in the neighbourhood of the gall-bladder as a result of gall-stones. It has also been observed, as before mentioned by Parkes, coupled with a reduction in all the urinary solids, and probably due to imperfect elimination. On the other hand, where urea is increased the output scarcely ever attains that possible on a diet containing excess of proteids in absence of fever.

The cause of increased excretion of urea in fever.—It is universally acknowledged that the increased production of urea is due to increased metabolism of proteids, chiefly in the muscles; a summary of the evidence that this is so will be found in a recent paper by Ed. Aronsohn (39). It remains only to account for the rising output with falling temperature and for the post-critical increase when this occurs. As regards the first of these, a similar phenomenon appears in simple inanition as the store of carbohydrates becomes exhausted; it seems, therefore, reasonable to attribute the increasing output of nitrogen in fever, in part at any rate, to the same cause. This is, in fact, the suggestion made by May (17). Other causes might, however, come into operation, for the loss of heat is less earlier in the fever, also the resistance of the cells may diminish later, so that a toxine may then have a direct action upon them which it had not before. For the post-critical increase many explanations have been offered; that perhaps most widely accepted (Parkes, Huppert, Riesenfeld, Unruh, Cohnheim, Murchison, and others) is that there has been previously a retention of imperfectly metabolised matter which is only then converted into urea. Schultzen (31) has objected to this on the grounds that the precursors of urea are very soluble and diffusible, and should appear in the urine, as may happen in liver disease. It is not, however, necessary to assume that the metabolised proteids have reached a diffusible form. Further, von Jaksch (32) has recently demonstrated the presence of considerable quantities of amido-acids in the urine in febrile and other conditions. Fraenkel (33) has attributed the post-critical increase to a previously impaired kidney function, and supported his theory by referring to evidence of kidney disease. It is, however, difficult to believe that a diseased kidney would so speedily and suddenly recover. Lastly, von Moraczewski accounts for the phenomenon by supposing certain variations to occur at this time in the normal interchange of water and other matters between the blood and the tissues,

resulting in a flow from the latter of water and the products of metabolism. These unusual currents between blood and tissue are things very difficult to demonstrate or disprove; but it may be pointed out that a large and delayed excretion of urea occurs in scarlet fever before the temperature has fallen, and therefore before this hypothetical tide is supposed to have turned. The explanation given first seems, therefore, to have most in its favour, and it is supported by the observation of von Moraczewski himself, which has been confirmed by Hatcher and Sollmann (34), that large doses of sodium chloride cause a considerable increase in the loss of nitrogen in fever, presumably by accelerating metabolism. On the other hand, whether or no they have this effect in health is a matter that has been much debated, and the balance of evidence appears to show that they do not. The inference would seem to be that metabolism in fevers requires, to enable it to be completed rapidly, some assistance, which it does not require in health. It is, however, possible, as Schultzen (31) suggested, that increased metabolism does not cease, in fevers ending by crisis, with the fall of temperature; also that in pneumonia, as Scheube (35) supposed, absorption of the exudate may play a part in causing this post-critical excretion, as may also, at times, diuresis.

Conclusions with regard to urea excretion.—1. The fevers here investigated cause a notable increase in the excretion of urea.

2. This excretion bears no direct relation to the height of the temperature at the time.

3. The maximum excretion in these fevers is usually attained before the temperature returns to the normal.

The relation of urea to uric acid, urinary water, potassium, and the acids of metabolism will be considered under "uric acid" and "potassium."

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On the Excretion of Uric Acid.

Physiological variations.—A normal adult on mixed diet excretes in twenty-four hours from ·2 to 1·25 g. of uric acid, 1—2 per cent. of the total nitrogen being in this form (Huppert, 1). It is generally believed that a considerable fraction of the excreted acid is derived directly from allied bodies introduced in the food. The experiments of Hopkins and Hope (2) have demonstrated not only that digestive leucocytosis does not in itself increase uric acid excretion, but also that the above bodies are not necessarily nucleins containing phosphorus. According to Jerome (3) they are, however, if not of this nature, at any rate alloxur bases allied to uric acid in composition.

On a milk diet this "exogenous" uric acid disappears, and there remains only the "endogenous" remnant. According to the recent observations of Kaufmann and Mohr (4) this latter quantity averages between ·3 and ·5 g. daily for an adult. The average of my two test cases, who however differed considerably, was ·45 g.; their diet contained, besides milk, also one egg. Eggs are said to be free from nuclein, but whether they introduce any alloxur nitrogen is a matter about which there has been difference of opinion. In any case the quantity in the yolk of one egg would probably be a fairly constant one.

Whether endogenous uric acid is produced exclusively from nuclein and alloxur bases or by a synthetic process is a matter scarcely yet settled. It is this endogenous portion with which we are concerned in a study of the febrile process, hence such study may be expected to throw some light on the above question. A most interesting contribution to the literature of uric acid has lately been supplied by Soetbeer and Ibrahim (5), who have demonstrated that uric acid taken in solution by the mouth is not absorbed, but excreted as some other nitrogenous body in the fæces, while if injected subcutaneously it is rapidly excreted as urates by the kidneys, and causes subsequently increased formation of uric acid. The effects of administration

of uric acid to man would seem, therefore, to differ from those obtained with animals.

The effects of the fever.—Of the old writers, Simon (6) stated that uric acid excretion was always increased, both in fevers and inflammatory conditions, even though urea was diminished. Ranke (7) found increased excretion in pneumonia after the crisis. Parkes (8) found an increase in nearly all fevers, not, however, in erysipelas; in pneumonia the output was largest during resolution. Unruh (9) found increased excretion in typhus, typhoid, and relapsing fevers; in pneumonia, especially after the time of the crisis, and in erysipelas. The increase was in general about proportional to that of urea; indeed, the average output during fever, namely, ·844, bore almost the identical relation to the normal for the diet, that the excretion of urea in fever did to the same. The largest excretion was 2·169 g. in a case of pneumonia. Scheube (10) also found increased excretion in pneumonia, particularly after the crisis, and on the whole in proportion to that of urea. On the other hand Wyss and Bock (11) found no increase in relapsing fever, Buchanan (12) none in typhus, and Gee (13) none, but, on the contrary, great diminution in scarlet fever; while Bartels (14) found a relative if not absolute diminution in all fevers unaccompanied by dyspnœa or other respiratory disturbance leading to defective oxygenation, *e. g.* abnormally slow respiration. With the onset of such a complication increase occurred, and he attributed it to failure in the normal oxidation of proteids. Robins (15), on the other hand, found that, in variola, uric acid was excreted in large amount all through the fever until the suppurative stage was passing off, when the excretion usually fell, to rise again during convalescence. In some cases a critical discharge occurred. It may be mentioned that according to von Limbeck (16) leucocytosis is not present before the suppurative stage in this disease.

The theory that excess of uric acid indicates defective

oxygenation has been recently revived by the Russian Professor Poehl (17), who groups with it the other nitrogenous extractives, and also neutral sulphur. All these bodies, as well as the aromatic sulphates, are regarded by him as an index of auto-infection, associated with deficient aëration and diminished alkalinity of the blood. The condition of body indicated by excessive production of the above excretions predisposes, he thinks, to infection. Somewhat similar views are held by Haig (18) with regard to uric acid, with, however, this difference, that he considers the uric acid to be the cause and not the result of the metabolic disturbance. All the earlier work was carried out by the method of Heintz, which is open to objection. Further the influence of diet was not then fully recognised, and, indeed, little attention has been paid to this by most of the later writers also. The first work by more accurate methods with which I am acquainted is that of Cario (19), who used the Folker-Salkowski process, and estimated also not only urea but the acids as well. His cases included (*a*) one of typhoid; (*b*) one of pneumonia; (*c*) one of miliary tuberculosis; (*d*) one of meningitis (septic); (*e*) one of typhlitis; and (*f*, *g*) two of phthisis. The average excretion of uric acid was (*a*) ·90 : ratio to urea 1/37; (*b*) 1·20 : 1/35; (*c*) ·87 : 1/46; (*d*) 1·06 : 1/40; (*e*) 1·08 : 1/39; (*f*) ·81 : 1/27; (*g*) ·90 : 1/30 respectively. The ratio of uric acid to urea was, therefore, little different in typhoid and pneumonia, although leucocytosis is commonly absent in the first and conspicuous in the second, while uric acid was proportionally high in both cases of phthisis. Wasting would, therefore, seem to have more influence than leucocytosis upon this ratio. Further points of interest in Cario's work were these:—although uric acid and urea tended to rise and fall together, if the temperature fell, the critical discharge of urea was more transitory than that of uric acid, so that subsequently the uric acid urea ratio was altered in favour of the former. This point was specially well illustrated in the case of pneumonia, but appeared in

that of typhoid as well. Cario studied the effects of inanition also, and found that they were very similar to those of fever, while feeding tended to produce a return to the normal. Two years after the publication of Cario's work appeared that of Gerdes (20). He used the same method for uric acid, but estimated total nitrogen instead of urea. His cases were five of pneumonia, one accompanying nephritis, one of typhoid, one of phthisis, which ended fatally, and his results generally confirmed those of Cario, the critical or post-critical increase in uric acid outlasting that of urea, so that the former was, in all the uncomplicated cases of pneumonia, not only relatively but absolutely highest in the post-febrile period, and usually two or three days after the crisis. Some of these excretions were quite abnormally large, *e. g.* 3·69 g. of uric acid to 32·09 g. of nitrogen, the former yielding 3·83 per cent. of the latter. The days of fever investigated were generally few. In the uræmic case the uric acid excretion was absolutely and relatively low. In that of typhoid, where many days of pyrexia were studied, the large absolute and relative excretion appeared with a falling temperature. The case of phthisis showed high absolute and relative excretion towards the end, but nothing approaching that of one of the pneumonia cases.

The discoveries of Horbaczewski have caused modern workers to pay special attention to leucocytosis in the study of uric acid, but though the work published on this subject is very extensive, unless I have overlooked it, no large amount has been done on febrile conditions. The following must, however, be mentioned.

Richter (21) contributes a valuable paper in which uric acid, total nitrogen, and leucocyte counts are recorded in various conditions. I am here concerned only with that bearing on febrile metabolism from which I have abstracted the following. The averages here given I have calculated from Richter's figures, but they do not appear in his paper.

Disease.	Fever.			Convalescence.				Leucocytosis.
	Aver. $\frac{U}{}$	Aver. N	$\frac{N}{U}$	Aver. $\frac{U}{}$		Aver. N	$\frac{N}{U}$	
1. Typhoid .	·73	9·73	13·3	·50	—	6·68	13·4	Little throughout.
2. „ .	·71	8·33	11·7	·41	—	6·28	15·3	„ „
3. Phthisis .	·74	6·92	9·4	—	Chronic	—	—	„ „
4. „ .	·98	11·83	12·1	—	„	—	—	„ „
5. Septicæmia .	·84	14·92	17·7	—	Fatal	—	—	Much throughout.
6. Septic angina	·70	6·77	9·7	·76	—	7·82	13·9	Considerable in fever.
7. Parametritis	·94	9·85	9·0	·75	—	8·38	11·0	„ „
8. Pneumonia .	·68	10·63	15·6	·96	—	11·72	12·2	Moderate.

The maximum leucocytosis occurred in No. 5, the white cells amounting on one day to 30,420 in a c.mm.; here uric acid is absolutely moderate and relatively low. In the case of pneumonia the largest excretion, absolute and relative, occurred during convalescence when leucocytosis had diminished. Only in the case of angina was any distinct correspondence found; here, on the day when the abscess burst, there was a fall in leucocytosis and uric acid. Richter admits that his results but partially confirm the theories of Horbaczewski, and that fever in itself is a factor to be reckoned with, apart from leucocytosis.

Kühnau (22) has estimated uric acid in a number of cases of pneumonia, and counted leucocytosis daily. He thinks that an increase in uric acid excretion corresponds with a fall in the number of white cells. While this is the case in his leucocythæmic patients, the relation between these two occurrences is by no means conspicuous in his cases of pneumonia. Indeed, little relation direct or inverse can be traced between the leucocytes and the excretion of uric acid in these cases. Kühnau accepts Salkowski's dictum that the simultaneous investigation of urea or total nitrogen is superfluous. The Ludwig-Salkowski process was used in the analysis by both Richter and Kühnau. Dunin and Nowaczek (23) have estimated uric acid in five cases of pneumonia, but leuco-

cytes were not counted, and Haycraft's method was used for uric acid analysis. These authors confirm the observation of the great majority of workers—namely, that uric acid excretion is, in this disease, always largest, absolutely and relatively, after the temperature has fallen. They do not connect this phenomenon with leucocytosis, but with absorption of the pulmonary exudate, and show a definite correspondence in point of time between the two occurrences. Kühnau and Weiss (24) have published a large number of analyses of uric acid and alloxur nitrogen; here total nitrogen was estimated, and leucocytes counted. I will mention only that bearing on my subject. In three cases of typhoid there was small absolute and relative excretion of uric acid and little leucocytosis, so that some confirmation of the theory of Horbaczewski was afforded. A case of phthisis treated with tuberculin showed leucocytosis with each injection; there was a small increase of uric acid, which sometimes accompanied and sometimes followed the leucocytosis, but was accompanied by a decided rise in total nitrogen. In a case where a wound became infected with *Bacillus pyocyaneus*, great leucocytosis followed, the increase in white cells being accompanied by a steady rise in uric acid. Nevertheless, the correspondence throughout between total nitrogen and uric acid is at least as close as between the latter and leucocytosis, and the largest excretion, 1·679 g., is indeed accompanied by enormous leucocytosis, 67,000 in a c.mm., but also by 24·38 g. of total nitrogen, ratio 1 : 14·5. Moreover, there is no proof that any unusual leucolysis was in progress.

In one case of Hodgkin's disease pilocarpine produced leucocytosis with a trifling increase of uric acid, in another extreme leucocytosis followed, and the case was changed to one of acute leucocythæmia. Here large excretion of uric acid was indeed produced, but as the patient went rapidly from bad to worse, and died within a month, it is legitimate to suppose that considerable disturbance of the ordinary processes of metabolism arose. Von Moraczewski

(25) found uric acid to vary on the whole with urea in various fevers.

Kaufmann and Mohr (4) are the first to use a nuclein free diet during the study of febrile metabolism in connection with uric acid. In three cases of pneumonia they found, in spite of the diet, increased excretion of uric acid, which might occur before as well as after the crisis. Only a few days excretion were, however, investigated. In their work, as also that of Kühnau and Weiss, alloxur nitrogen varies fairly steadily with uric acid.

In respect to tertian and quartan ague, Rem Picci (26), von Limbeck (27), von Moraczewski (25), and Hitzig (28) have shown that uric acid shows during the fever much less increase than urea, though a small rise may occur as the temperature falls. This behaviour doubtless lends support to the theory of leucocytic origin of uric acid, for this is a fever in which leucocytosis is absent. It must, however, be borne in mind that active changes are probably in progress in the spleen, and further, that the twenty-four hours excretion of phosphoric acid is usually increased, suggesting that leucolysis occurs in this organ.

Author's results.—Passing now to my own work, the introduction by Hopkins of a method at once simple and accurate for the estimation of uric acid has enabled me to produce a considerable number of results of such analysis, in spite of the simultaneous investigation of so many other urinary ingredients. The only modification which I have found it necessary to make in his process is to wash off the ammonium urate with hot 5 per cent. hydrochloric acid instead of hot water. A large sticky precipitate, such as is common in working with febrile urines, is thus much more easily removed; no further addition of acid is necessary, and its strength is uniform. Hopkins has himself adopted this slight modification at my suggestion.

I have grouped my uric acid results in the same way as those of urea, and added, with the averages, those of urea for the same samples. Excretions influenced by salicylates or alkalies are omitted.

Twenty-four hourly excretions of uric acid in grams.

A. *Cases of scarlet fever.*

Group.	No. of samples.	Maximum.	Minimum.	Aver. $\bar{U}$.	Aver. $\overset{+}{U}$	Ratio $\frac{\overset{+}{U}}{\bar{U}}$
1. With temp. of 103° and over .	15	1·13	·44	·72	32·54	45·2
2. „ 102°—103° .	8	·85	·38	·70	32·58	46·5
3. „ 101°—102° .	12	1·50	·49	·95	42·96	46·3
4. „ 100°—101° .	12	1·89	·77	1·20	49·44	41·2
5. „ 99°—100° .	7	1·44	·63	·95	35·41	37·3
6. „ Under 99° .	5	1·00	·58	·71	28·19	39·7
7. On fish or meat diet . .	21	1·50	·43	·92	31·36	34·1

On milk diet: Average of 47 samples for temperature of 100° and over, $\bar{U}$ = ·90. $\overset{+}{U}$ = 39·65. $\frac{\overset{+}{U}}{\bar{U}}$ = 44·1.

On milk diet: Average of 12 samples for temperature below 100°, $\bar{U}$ = ·85. $\overset{+}{U}$ = 32·40. $\frac{\overset{+}{U}}{\bar{U}}$ = 38·1.

B. *Cases of morbilli.*

Group.	No. of samples.	Maximum.	Minimum.	Aver. $\bar{U}$	Aver. $\overset{+}{U}$	Ratio.
1. With temp. of 103° and over .	6	·96	·32	·69	34·81	50·5
2. „ 102°—103° .	3	·67	·57	·63	23·78	37·7
3. „ 101°—102° .	5	·97	·67	·82	30·91	37·7
4. „ 100°—101° .	3	·64	·58	·61	24·46	40·1
5. „ 99°—100° .	3	·79	·42	·61	26·06	42·7
6. „ Under 99° .	11	·75	·26	·49	24·60	50·2
7. On fish or meat diet . .	18	1·22	·42	·79	28·70	36·3

On milk diet: Average of 17 samples for temperature of 100° and over, $\bar{U}$ = ·70. $\overset{+}{U}$ = 29·89. $\frac{\overset{+}{U}}{\bar{U}}$ = 42·7.

On milk diet: Average of 14 samples for temperature below 100°, $\bar{U}$ = ·56. $\overset{+}{U}$ = 25·63. $\frac{\overset{+}{U}}{\bar{U}}$ = 45·8.

c. *Cases of Scarlet Fever* (12), *Morbilli* (10), *Rubeola* (4), *and Tonsillitis* (1) *together.*

Group.	No. of samples.	Maximum.	Minimum.	Aver. $\bar{U}$	Aver. $+\bar{U}$	Ratio $\frac{+\bar{U}}{\bar{U}}$
1. Temp. of 103° and over . .	22	1·13	·32	·73	33·64	46·1
2. „ 102°—103° . .	11	·85	·38	·68	30·18	44·4
3. „ 101°—102° . .	17	1·50	·49	·91	40·12	44·1
4. „ 100°—101° . .	18	1·89	·58	1·04	44·24	42·5
5. „ 99°—100° . .	11	1·44	·42	·81	32·07	39·6
6. „ Under 99° . .	19	1·00	·26	·57	27·38	48·0
7. On fish or meat diet . .	49	1·50	·42	·79	29·39	37·2
On milk diet: Average of 68 samples for temperatures of 100° and over, $\bar{U}$ = ·85. $+\bar{U}$ = 37·51. $\frac{+\bar{U}}{\bar{U}}$ = 44·1.						
On milk diet: Average of 30 samples for temperatures of below 100°, $\bar{U}$ = ·66. $+\bar{U}$ = 29·09. $\frac{+\bar{U}}{\bar{U}}$ = 44·1.						

Comparing with these the average of the test cases, namely, ·45, the ratios thereto become 1·89 and 1·47 to 1 respectively, whereas the corresponding ratios were, in the case of urea, 1·70 and 1·34 to 1.

The above figures, representing the excretions of nearly 100 days, on nuclein free diet of twenty-seven patients specially selected as suffering from acute fever, all of the same sex, and differing not very widely in age and condition, may perhaps allow of some conclusion to be drawn as to the effects of pyrexia *per se* on the excretion of uric acid, when the disturbing influence of ingested nucleins and inflammatory exudates are alike eliminated.

It is seen at once that under these conditions the febrile state influences uric acid in the same way as urea; indeed, this fact is suggested by most of the work previously published. In neither case is there direct relation between the temperature curve and the amount of the excretion, which increases with a fall in temperature until 100° is reached, and then again drops. As compared with other febrile conditions, the excretion is relatively less than in phthisis, and absolutely and

relatively less than in pneumonia. In morbilli it is absolutely somewhat less than in scarlet fever, but during the fever relatively somewhat larger, although the latter is a fever in which leucocytosis is active and persistent, and the former one, in which it is absent altogether.[1] A comparison of the leucocyte count in these two diseases, with full references to previous literature, will be found in two papers by Reckzeh (29). As regards scarlet fever, the work of Sevestre (30) and of Bowie (31) may also be consulted. In fact, I find very little evidence in my work, or, indeed, in that of others, that presence or absence of leucocytosis has influence upon this ratio in the febrile state.

The next point of interest is that, although as compared with that of normal persons on the same diet, uric acid excretion in fever is even more increased than is that of urea; nevertheless, the latter is still in excess as compared with the excretion of a normal man on ordinary diet or of the same patient during convalescence, so that even high fever has less effect than diet in influencing this relation in favour of uric acid.

It remains now to compare the excretion of uric acid with that of certain other urinary ingredients, and first of all with that of water. For this purpose I will place side by side with the averages of urea and uric acid just given those of urinary water previously quoted.

Group.	Water.	$\frac{U}{U}$	$\frac{+U}{U}$	$\frac{+U}{\frac{U}{U}}$
1 ...	890 c.c. ...	·73 ...	33·46 ...	46·1
2 ...	811 „ ...	·68 ...	30·18 ...	44·4
3 ...	1080 „ ...	·91 ...	40·12 ...	44·1
4 ...	1098 „ ...	1·04 ...	44·24 ...	42·5
5 ...	922 „ ...	·81 ...	33·07 ...	39·6
6 ...	664 „ ...	·57 ...	27·38 ...	48·0
7 ...	1171 „ ...	·79 ...	39·38 ...	37·2

[1] Recently it has been shown that leucocytosis occurs in morbilli during the period of incubation, but disappears during the eruptive period (38).

There is thus a marked correspondence between the three excretions; moreover, to further illustrate this relationship, I have abstracted five each of the lowest and highest uric excretions and append them below, with the urea and water which correspond to them.

Water	.	1780	1636	1223	1139	1630	550	739	534	480	715
Urea	.	85·50	58·87	66·60	53·76	35·32	22·95	25·21	25·10	20·90	29·06
Uric acid		1·89	1·57	1·42	1·34	1·08	·50	·49	·44	·38	·32

The frequency with which a large excretion of uric acid is accompanied by a large excretion of water suggests that it possesses diuretic properties similar to those of caffeine. On the other hand if diuresis is induced by merely taking large quantities of water, uric acid excretion is said not to be increased, but rather diminished.

The relation of uric acid to phosphoric acid is of much interest in connection with the question whether or no uric acid is derived from nuclein. Cario estimated both, and I reproduce here the maximum and minimum excretions of uric acid of the five cases in which the analyses were continued over more than two or three days, with the phosphoric acid corresponding.

		C		P_2O_5.			U		P_2O_5.
Max.	1	1·03	...	2·13	Min.	1	·69	...	1·81
	2	1·50	...	1·85		2	·82	...	1·57
	3	1·06	...	4·00		3	·71	...	2·72
	4	1·45	...	3 30		4	·48	...	·86
	5	1·11	...	1·87		5	·57	...	1·19

The relationship between the two excretions is by no means conspicuous. Osler (32) gives a single chart prepared by Futcher [1] showing the hourly excretion of uric acid and phosphate in a case of gout. The curves run closely together. As, however, urea is not given, it is at

[1] Further charts have since been published by Futcher (39) in confirmation of his opinion, but the correspondence between the two excretions in two out of three of these is not striking, and if sulphuric acid had been selected, the parallelism would have been in all probability equally marked.

least possible that the correspondence was due merely to a parallelism between both the first-mentioned excretions and the latter. He states that Bain finds a relation between uric acid and phosphates, but Watson no such relation. I have made a number of two-hourly analyses of uric acid and phosphates in health (33), and I have failed to find any constant connection between the two excretions, whether during rest or exercise, whether during abstinence from food or after a large meal. In fact, although these frequent analyses should render more apparent the correspondence between the two excretions did it exist, they serve only to accentuate the lack of parallelism between them, so that a maximum output of the one not rarely coincides with a minimum of the other.

As regards the excretion of free acid and uric acid in fever, the only parallel analyses of the two with which I am acquainted are those of Unruh (8). No direct or inverse relation can be traced between them in his tables; they vary independently. Gerdes (19) endeavours to trace an inverse relation, but, as he merely tested the acidity qualitatively, and never estimated it, his figures are not convincing.

For the purpose of comparing acidity, uric acid, and phosphoric acid excretion I have abstracted all the figures from my cases of scarlet fever and morbilli where these three were simultaneously estimated and the patients were on milk diet and grouped the averages below.

Averages of acidity (as oxalic acid), uric acid, and phosphoric acid in grams for twenty-four hours.

Group.		No. of samples.	Acid.	U	P_2O_5.
1	Temp. of 103° and over	20	2·95	·69	2·15
2	„ 102°—103°	11	1·94	·74	1·69
3	„ 101°—102°	15	2·23	·87	2·04
4	„ 100°—101°	9	2·69	·88	2·44
5	„ 99°—100°	11	2·68	·90	2·89
6	„ under 99°	14	1·83	·57	2·21

The relation between uric acid and phosphate is shown to be by no means so close as that between the former

and urea or even urinary water; indeed, there is about as much direct relation between acidity and uric acid as between phosphoric acid and the same. To further illustrate this lack of correspondence I have picked out all excretions of uric acid over 1·0 gram and append them with the phosphoric acid corresponding; I add also, for comparison, the sulphuric acid.

P_2O_5, $\overline{U}$, and SO_3 in grams for twenty-four hours.
Patients all on milk diet.

P_2O_5		$\overline{U}$		SO_3	P_2O_5		$\overline{U}$		SO_3
1·51	...	1·04	...	2·34	·97	...	1·34	...	3·26
2·49	...	1·05	...	2·12	2·53	...	1·39	...	2·72
2·89	...	1·05	...	3·11	·75	...	1·42	...	3·70
2·81	...	1·05	...	2·34	4·48	...	1·43	...	2·39
4·54	...	1·06	...	2·97	4·92	...	1·44	...	3·46
1·86	...	1·08	...	2·02	3·76	...	1·44	...	2·31
·67	...	1·09	...	4·03	2·65	...	1·49	...	2·72
3·05	...	1·11	...	2·44	3·39	...	1·50	...	3·51
3·70	...	1·12	..	2·11	2·78	...	1·57	...	4·63
2·60	...	1·13	...	2·73	2·73	...	1·78	...	4·80
2·34	...	1·16	...	2·26	2·65	...	1·89	...	5·19
4·58	...	1·16	...	3·80					

Wide discrepancies are seen to occur between uric acid and phosphate excretion. Moreover, while, as compared with excretion of a normal man on the same diet, uric acid is excreted in quantity out of proportion to urea, phosphoric acid is, on the contrary, relatively reduced. Indeed there is, as is shown above, more intimate relation between the output of sulphuric acid and that of uric acid than between that of phosphoric acid and the same. Thus, when the disturbing influence of food is eliminated, and when the production of endogenous uric acid is conspicuously increased, evidence that the latter is produced from phosphorus-holding substances is not conclusive.

On the other hand, Williamson (34) has found in cases of tuberculosis that a diminution in the number of the mature forms of white corpuscles was generally followed by an increased excretion of phosphoric acid and uric

acid. In criticism of this paper it was, however, pointed out by Halliburton that all the leucocytes in the body, if formed into solid tissue, would constitute an organ only as large as a marble, and the daily destruction of the entire quantity would influence uric acid excretion very little. He contends that it is to the nuclei of the solid tissues that we must look for the origin of uric acid. Woods-Hutchinson (35) maintains, on the contrary, that these nuclei are mere "boarders" in the cell, and the products of their metabolism can only reach the circulation when the cell itself dies. Taken together these two opinions form a serious objection to the theory of the nuclear origin of uric acid. I would further point out that in fever the glandular organs do not waste, but rather increase in bulk; yet uric acid is excreted in excess. As regards the relation of uric acid to acidity this is, on the whole, rather direct than inverse, and, indeed, I believe this is usually the case both in health and in the febrile state.

Why is uric acid excretion increased in fever?—The relatively and absolutely large excretion after the crisis in pneumonia, much in excess of anything that could be produced by the destruction of circulating leucocytes, which then show no rapid diminution, suggests that the absorption of the exudate has a direct influence. Before assuming that nucleins in this exudate are the origin of the excretion it would be well to try the effects of introducing into the circulation, or even into the stomach of an animal, nuclein-free extracts of hepatised lung. It is not improbable that results would be obtained similar to those of Hopkins already referred to. Meanwhile I prefer to exclude cases of pneumonia from consideration. In other fevers the closer relation of uric acid to urea and sulphuric acid than to phosphoric acid suggest that the origin of the first group is one and the same, namely, the proteids of muscle, and this opinion is confirmed by the wasting of these and the absence of similar wasting of glandular structures. Gumlich (36), indeed, concluded that the

extractives were excreted in excess whenever the body lost weight. The hypothesis of Roberts, according to which we have in uric acid a vestigial relic of an earlier type of excretion has, as Hopkins (37) remarks, never been disproved, and it is more conformable with comparative physiology and the theory of evolution than is that of Horbaczewski. Woods-Hutchinson, indeed, objects that many invertebrates excrete urea as well as uric acid, and that neither birds nor serpents are in the direct line of human ancestry. I fail to follow him here. That in the course of evolution from invertebrate ancestors man should have passed through a stage in which uric acid was excreted exclusively is improbable; let him, however, develop from a lower type which produces both, and let birds and reptiles arise from the same, the mammal evolving in one direction and the bird and reptile in another, and the difficulty disappears. He also repeats Garrod's argument, namely, that birds are active and warm-blooded. It is not, however, obvious why they should on this account produce an excretion which would be only an inconvenience to them.

Is it not possible that when the urea-producing animal is in difficulties from any cause, whether as the result of introducing highly resistant proteids such as nucleins, of conditions of anæmia, of dyspnœa, of toxæmia, of leucocythæmia, or general metabolic depression, it tends to revert to that archaic excretion, which can be made in several organs, and requires less oxygen and less expenditure of energy?

Conclusions.—1. The effects of fever upon the excretion of uric acid are similar to the effects produced on the excretion of urea by this condition. Both are alike influenced directly by changes in the urinary water.

2. The excretion of uric acid in fever bears no very close relation to that of phosphoric acid, and a study of its behaviour in this condition suggests that endogenous uric acid is produced from proteids rich in nitrogen and sulphur and poor in phosphorus.

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On the Excretion of Kreatinin.

Physiological variations.—A normal man, on mixed diet, excretes daily from ·6—1·3 g. of kreatinin. This quantity varies much with diet. According to Hofmann (1), on a diet free from kreatinin, the excretion falls to that during abstinence. It is increased by meat and reduced by vegetable diet, but uninfluenced by rest and exercise. The small influence of exercise was observed before Hofmann's paper was published, and has been demonstrated also by Dunlop, Noël Paton, and Macadam (2). There have been, however, differences of opinion on this matter.

Effects of fever.—That the output of kreatinin was increased by fever was discovered by Munk (3). Hofmann confirmed this observation especially as regards pneumonia, the output in the latter disease being raised by 47 to 56 per cent. as compared with the normal on the same diet. An increase in the excretion of substances reducing Fehling's solution, among which may be included kreatinin, has been observed also by Moritz (4) in febrile cases, particularly pneumonia. Unruh (5) estimated kreatinin in various fevers, and found a decided increase during the fever, which sometimes persisted during convalescence; the average during the febrile period was 1·006 g., or about double the normal for the diet, so that the influence of fever on this excretion was greater than that on either urea or uric acid. Senator (6) has, however, failed to find any increase in tetanus.

On certain other Nitrogenous Excretions, not including Ammonia.

Effects of fever.—I have already mentioned that the alloxur nitrogen runs, in general, parallel with uric acid iu the febrile state. This is shown in the results of Kühnau and Weiss, of von Moraczewski, and of Kaufmann and Mohr. The xanthine bases are never excreted in large amount, as is shown by the figures of the last-named authors and of von Moraczewski.

As regards the amido-acids a most important contribution to our knowledge of febrile metabolism is furnished by von Jaksch (7), who has shown that in typhoid fever the excretions of these bodies may attain proportions which have, I think, never been before suspected, and second only to those which they attain in such conditions as phosphorus poisoning and acute yellow atrophy of the liver,—in fact, 35 to 39 per cent. of the total nitrogen may be in this form. Further, in pneumonia this quantity may amount to 19 per cent., and to nearly as much in tuberculosis. Obviously these results open up a new field of research for the student of nitrogen metabolism in the febrile state. My own study of the acidity of urine in fever, and indeed in health also, had long ago led me to suspect that acid substances were present in urine in considerable quantities, which were not estimated as acid phosphate, and gave no reaction with Congo red. I shall have occasion to discuss this when dealing with acidity.

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On the urinary pigments.—That the excretion of the colouring matter of the urine was increased in fever was observed long ago, among others by Parkes. This increase was found to be absolute, and not due to concentration. I can confirm this observation. I would add that the difference between a normal urine and a febrile urine in this respect is accentuated, if the two samples, made up to the same volume for the twenty-four hours excretion, are boiled with hydrochloric acid. The originally darker colour of the latter shows even greater intensification than does that of the former. After fever the pigment is frequently abnormally deficient. As I have done no special work on the urinary pigments the following remarks are taken entirely from the Bradshaw Lecture of 1900, by A. E. Garrod.

Urobilin, which in normal urine appears solely as a chromogen, and only in very small amount, is found ready formed in the urine during febrile disorders of almost every kind, the duration of the urobilinuria corresponding with that of the pyrexia. The presence of albuminuria tends, however, to prevent the appearance of urobilin.

Hæmatoporphyrin is not uncommonly found in febrile urine, its presence being probably due to some disturbance of the function of the liver. Thus it is apt to be considerably increased in cases of phthisis with fatty liver, in gout a disease in which fatty or cirrhotic changes in the liver are common, and in rheumatism where cloudy swelling is constant, as it is, indeed, in most fevers. Mere traces of hæmatoporphyrin appear in normal urine.

Urochrome is the most abundant of the urinary pigments, but owing to the difficulties attending its estimation and distinction from other pigments, nothing seems to be known as to the effects of fever upon its excretion.

Uroerythrin is probably not strictly a normal constituent of urine, but it is often excreted in a large amount of fevers. A large excretion is, however, uncommon in typhoid, and, as in the case of urobilin, nephritis is usually

unattended by the presence of this pigment in the urine. It may, however, appear in spite of albuminuria.

On the odour of urine.—I should not think it worth while to mention this but that somewhat remarkable statements have been made about the odour of the urine in scarlet fever. My experience is that in this and in other fevers the normal odour is slightly more pronounced. Quite exceptionally during the acute stage the urine has, in spite of acidity, the odour of decomposition. I imagine this to be due to accidental infection with some organism which will flourish in acid media; it is quite uncommon, and I do not connect the occurrence with presence of fever. Generally, I think, the urine of febrile patients has little, if any, more tendency to decompose than that of normal persons. The pale and sometimes abundant urine of the post-febrile period does, however, show unusual tendency to decomposition. I am informed that Mahomed observed this tendency when he was on the staff of this hospital

On the Excretion of Ammonia.

Physiological variations.—The daily excretion of ammonia in health varies considerably, *e. g.* from ·3 to 1·2 g., averaging ·6 to ·8 g. (Neubauer, 1). It has been shown by Coranda (2) that meat diet increases and vegetable diet diminishes the excretion in men and dogs alike. When, however, a sudden change is made from meat to vegetables ammonia excretion does not fall so rapidly as that of the total nitrogen (Gumlich, 3; Rumpf, 4). Walter (5) showed that dogs, by producing ammonia, were able to prevent reduction of the alkalinity of their blood by acids, while rabbits failed to do so and succumbed. To what extent man possesses this power is less certain, the results obtained by administration of acids being here less decisive (6, 7, 8, 9), and the diseases during which large excretions of ammonia occur, *e. g.* diabetes, being accompanied not only by acid formation, but disturbances of metabolism which might themselves be a cause of ammonia production. Von Limbeck (7) considered that man resembled the herbivora rather than the carnivora in this respect, while Rumpf (6) denies to ammonia any alkalising

function whatever. Again, Keller (10) has shown that children are very susceptible to only moderate doses of acid, which produce in them a whole train of metabolic changes which must be considered pathological.

The effects of fever.—This subject was investigated first by Duchek (11) in 1864, since then by Koppe (12), Hallervorden (13), Bohland (14), Gumlich (3), Rumpf (4), von Limbeck (7), von Moraczewski (16), and Hitzig (17); a few observations have also been made by Leube (18), and Pick (19). All these authors agree that fever may increase absolutely or relatively the execretion of ammonia. The maximum observed by Duchek was 1·975 g., in a case of pneumonia; by Koppe 1·7 g., in one of typhus; by Hallervorden 2·66 g., in one of typhoid; but these figures are completely eclipsed by Rumpf with 5·927 g. of ammonia excreted by a case of pneumonia. All used Schlössing's process with the exception of Duchek. Koppe and Hallervorden estimated urea, Bohland and Gumlich urea, total nitrogen, and extractives; further, Hallervorden supplied analyses of sulphuric and phosphoric acid in some cases, von Limbeck of all the acids and bases, and von Moraczewski of the bases and phosphoric acid. Hitzig's work is concerned exclusively with malaria, but some of his analyses are very complete, including acids and bases, while all include total nitrogen, and some, uric acid. Gumlich's and Bohland's analyses were not carried out over long periods, and the latter's concerned only the night urine. Rumpf's results are mostly higher, and von Moraczewski's and von Limbeck's are mostly lower than those of others. To study the excretion more in detail, it is generally agreed that the increased output survives the fall of temperature and sinks but slowly; it may, indeed, persist far into convalescence. The crisis in pneumonia is apt to be attended by large excretion of ammonia, as of extractives; yet is this excretion insufficient, according to Pick, to cause that post-febrile alkalinity of the urine which he frequently finds in this disease, and attributes

rather to sodium than to ammonia. More marked even than the effect of the crisis is that of the onset of an inflammatory complication, while the largest excretion of all is shown by Rumpf to occur where such a complication follows hard upon this crisis. An interesting point noted by Gumlich is that in two cases of pneumonia the excretion on the day of the rigor was both absolutely and relatively low, no corresponding reduction occurring in the extractives; while in a fatal case ammonia was relatively high and exceeded the extractives; the total quantity was not here obtained. Von Moraczewski, on the other hand, in a fatal case of pneumonia, found little absolute or relative excretion of ammonia, and von Limbeck the same in a fatal case of phthisis. As regards the amount of ammonia excreted, of eighty-two days of fever, the average output found by Rumpf was 1·25 g. of ammonia nitrogen (1·516 NH_3) as compared with ·745 g. for thirty-two normal days and ·657 g. for fifteen days of convalescence; an increase of 67 per cent. over the first and 90 per cent. over the second group. The ammonia is moreover excreted in quantity out of proportion to the total nitrogen; thus while in health the relation of ammonia nitrogen to the total is 4·1 per cent. (Weintraud), 4·95 per cent. (Gumlich), or 4·64 per cent. (Rumpf), average 4·56 per cent., in fever, according to Gumlich, 6·2 per cent., and according to Rumpf 6·7 per cent. of the total nitrogen is excreted in this form, giving an average of 6·45 per cent. The ratio is thus changed by 1·89, an increase of 41·4 per cent. Bohland's figure for percentage of ammonia nitrogen is 5·72, but, as it represents only the night urine, I have not included it. The largest excretions found by von Limbeck are 2·1 ammonia nitrogen, or 8·7 per cent. of the total in pneumonia and 2·31 or 14·8 per cent. in erysipelas, in both cases three days after the fall of the temperature; the smallest ·13 g., or 2·74 per cent., in phthisis with a high temperature shortly before death. In fact, the excretion of ammonia in fever is irregular, so that, as Rumpf points out, on some days of fever there may be no increase,

while on other days without fever a large excretion may occur; especially is this the case, as before mentioned, in early convalescence. Not only are these fluctuations thus independent of temperature, but they may be independent of the total nitrogen; moreover the cases associated with the highest temperature are not necessarily those which excrete the most ammonia. As regards different fevers: in acute nephritis no increased excretion was found by Hallervorden, Gumlich, or Rumpf, nor was the relation to total nitrogen notably altered. Gumlich suggested that the diet is partly responsible for this. As to malaria, in Hallervorden's and von Moraczewski's cases, as also in von Limbeck's first case, ammonia is less increased than is total nitrogen. Hitzig's six cases show considerable variations, and in some the increase is large both absolutely and relatively; yet it shows no correspondence with the temperature, but has rather a tendency to follow the acme, not only of this, but also of nitrogen excretion. In one case with high fever ammonia supplied but 2 per cent. of the total nitrogen, in another without high fever 25 per cent. was in this form. In pneumonia the excretion of ammonia, as of uric acid, is high, averaging daily during the fever 1·355 g., in typhoid 1·05 g., and in rheumatic fever ·875 g. of ammonia nitrogen. In a case of cholera, when the patient is in the algid state, and when there is at the same time partial suppression of urine, the ammonia nitrogen may constitute 30 per cent. of the total. These figures are Rumpf's. Bohland, Gumlich, and von Limbeck find but a moderate increase in phthisis, but Leube states that in this disease ammonia excretion is increased quite out of proportion to the total nitrogen. In relapsing fever it is on the whole proportionate to urea in Hallervorden's tables, while in empyema he finds it high, as does Rumpf, both absolutely and relatively. In perityphlitis with abscess Gumlich shows it may also be absolutely and relatively high, falling after operation together with the extractives.

A certain relation between the excretion of sulphuric acid and of ammonia may be traced in Hallervorden's

tables, it is not, however, very close, and the relation to phosphoric acid is even less so. Von Moraczewski did not estimate sulphuric acid, but he traces a correspondence (23, *a*) between ammonia and phosphoric acid in typhoid, pneumonia, and phthisis. In a later paper (23, *b*) he claims that this correspondence applies to the acid phosphates, and this is so to some extent, not only in his work but in the few analyses given by Pick. Nevertheless acid phosphates tend to follow total nitrogen, and the ratio $NH_3 : N$ in von Moraczewski's work is a far more constant figure than is the ratio P : N. It is well known that the ratio $So_3 : N$ varies but little, and, as already mentioned in Hallervorden's tables, sulphuric is the only acid which bears any definite relation to ammonia. Yet, as I have shown in experiments on the effects of exercise (20), urinary acidity runs closely parallel with phosphoric acid, and is very little affected by the excretion of sulphuric acid; further, in my work the latter ran parallel with potassium, while ammonia corresponded with neither acid.

In the work of von Moraczewski and von Limbeck no inverse relation can in general be traced between ammonia and either of the fixed bases, but rather the contrary; ammonia and potassium run fairly parallel, while sodium seems to have little relation direct or inverse to the former. In another paper (16, *c*) von Moraczewski records that increased excretion of ammonia followed the administration of potash salts to a case of anæmia, a result which surprised him.

Author's results.—Passing now to my work, my figures are less numerous than I should desire, but are for the most part accompanied by simultaneous analyses of the acids, of free acidity, of urea, uric acid, and potassium and sodium. Further, the diet has been unusually uniform, and the cases have been carefully selected.

Excluding cases obviously influenced by drugs, of thirty-four samples from patients with temperatures of 100° or over, the maximum is 2·32 g. of ammonia, the minimum ·50, and the average 1·03 or ·848 g. of nitrogen. This is distinctly above the normal, and yet more above that of

the test cases on the same diet, the ratio to the latter being 2·5 : 1; it is nevertheless much below that of Rumpf for pneumonia and typhoid, and slightly below that for acute rheumatism. Of the urea corresponding with these thirty-four samples the average is 37·86. Of thirteen samples after the temperature has fallen, but while the patient is still on milk diet, the largest is 2·39, the least ·41, and the average ·966, or ·795 g. of nitrogen. Of the urea corresponding to these the average is 33·31. Of twenty samples after a return to fish or meat food, the maximum is 1·78, minimum ·32, and average ·78 or ·64 g. of ammonia nitrogen, the urea average being 31·50. The ratio of ammonia to urea in fever is 1 : 36·7, with temperature below 100°, 1 : 34·5, and after change of diet 1 : 40·4. The relative increase during fever in my cases is therefore, as compared with the excretion during convalescence, not very considerable. It must be borne in mind that my urea figures are all too high, but this applies almost equally during convalescence and during fever; nor is the error sufficient to account for the difference between my results and those of Gumlich and Rumpf. How much of this result is due to the use of milk diet and how much to the nature of the fevers studied, cannot be stated, but probably the last factor is not negligible. I should mention that I used Schlössing's method, and always left the samples five and usually six days; also that in many of the earlier cases no antiseptic besides the lime itself was employed. Any error is therefore unlikely to be on the side of deficit. The wide oscillations noted in the excretion of ammonia by Rumpf and others do not appear in my results, in fact the excretion runs fairly steadily with urea, and with uric acid and sulphuric acid, which also accompany the former; moreover it usually bears no relation to acidity unless this accompany urea.

Why is ammonia excreted in excess in fever?—The first to offer any definite explanation of this problem was Hallervorden (13), who considered that the question was one of acids and bases. He suggested that the fixed

bases are retained as a protection against acid poisoning, and that ammonia replaces them to a corresponding extent in combination with the acids excreted. The continued high excretion after fever was, he thought, due to retention of potassium coupled with continued high excretion of acids, especially sulphuric. This view of Hallervorden receives some support in recent work on the total alkalinity of the blood in fever, but the base retention of which is characteristic of fever is sodium, and the return of the sodium commonly occurs pretty rapidly with the fall of the temperature at a time when ammonia excretion is apt to be high. In the work of Hallervorden himself no parallelism is seen between ammonia and phosphoric acid, while that with sulphuric acid is not very close. Further, in the work of von Limbeck, von Moraczewski, and myself the relation of ammonia to potassium is direct rather than inverse, nor is inverse relation to sodium conspicuous. Again, as I shall presently show in dealing with potassium, the effect of increased excretion of sulphuric acid is in general rather to raise that of potassium beyond its usual proportion to the phosphates than to affect ammonia. This tends to confirm the opinion of Lunin (21), arrived at as the result of his experiments with salt-free food, that sulphuric acid, immediately it is produced, combines itself with the fixed bases either of the food or of the tissues, a conclusion strengthened by its lack of influence on urinary acidity. This question may, however, be tested in a simple manner by giving fixed alkalies. I have done so in the three cases, G. B—, No. 14, V. B. H—, No. 16, and W. H—, No. 18; the first taking citrate of sodium, the second taking citrate of potassium, the third both. In each case acid phosphates were estimated, and in the first two they were greatly reduced, to the advantage of the neutral salt, while in the last they disappeared. In the first two cases ammonia varied with urea much, as usual, the absence of noteworthy effect upon it being the same though the sodium was retained and the potassium excreted. In the third case

ammonia fell only from ·93 to ·87 with the large dose of alkali, and though it fell next day to ·33, the dose of alkali had then been halved, and urea and potassium fell likewise; sodium, however, rose. In a case of diabetes treated by Rumpf (29) with sodium citrate in 10 g. doses daily the excretion of ammonia actually attained 8·66 g., and averaged 5·7 g. per day. On the other hand, Gumlich (3) found that in cases of typhoid fever treated with hydrochloric acid the excretion of ammonia was unusually large. This result, taken in connection with my own, would seem to demonstrate that hydrochloric acid was contra-indicated in the treatment of fever. The conclusion suggested by both von Limbeck's work and mine is that the relation between ammonia and sulphuric acid is due rather to both being derived from the same class of proteids, rich in sulphur and nitrogen, than to any other cause. The explanation offered by Hallervorden is, however, accepted by von Noorden (30) and also by von Moraczewski, though the latter ascribed to phosphoric acid the principal *rôle*; indeed, until recently, no objection has, I think, been raised to it. Rumpf (4) made a quite original suggestion to account for the increase of ammonia in fever, namely, that it was a direct product of the micro-organisms causing the same, and, in order to test this hypothesis, he cultivated a number of pathogenic bacteria in various media, and examined the tubes for ammonia. His results were, however, chiefly negative; only by the bacillus of cholera and staphylo- and strepto-coccus pyogenes was any produced. He therefore fell back on the conclusion that the phenomenon under consideration was due to the grave disturbance in the normal processes of metabolism brought about by the disease. He allows acids absolutely no share in the matter. Without going so far as Rumpf, von Limbeck considered that the fixed bases are in health the important regulators of alkalinity in man as in herbivora, and the part played by ammonia is usually a small and secondary one; he pointed out, however, that in many fevers there

is no evidence of over-production of acids, and no loss of alkalies on the balance of intake and output. Personally I think that this matter can only be decided by observations on cases of fever wherein not only both acids and alkalies are estimated, but special attention is paid to evidence of disturbance in the normal metabolism of proteids; otherwise it is impossible to decide whether toxines or acids are the cause of the phenomenon. On the whole it seems to me that the evidence is in favour of the hypothesis of Rumpf rather than that of Hallervorden, and in reply to his criticism of Rumpf, that the latter neglected to study the acids, I would point out that he himself has neglected to study the bases. In fact, as regards the metabolism of fever at any rate, I would class ammonia, provisionally, with the extractives rather than with the alkalies, and it seems to me probable that other things besides acids can bring about an increased output, which is not necessarily protective, but perhaps merely a reversion to a simpler and older type of excretion.

As regards the ammonia of the blood in fever, Winterberg (24) has found that the chief difference between the blood in fever and in other conditions is that its ammonia is more variable. The average quantity in venous blood for afebrile cases was ·98 mgms. in 100 c.c., for febrile 1·14 mgms. On the other hand, the smallest amount, ·43, was found in a case of scarlet fever, and eight out of fifteen febrile samples yielded less than the average of the afebrile. It cannot, therefore, be said that high or low percentage of ammonia is characteristic of the blood of the fever.

Experimentally Noël Paton, Dunlop, and Macadam (25) have found no increased excretion of ammonia in dogs in which fever was induced by injection of diphtheria toxin. They found no increase in the sulphuric acid, but only in neutral sulphur, and they explained the former result by the latter, accepting the conclusion of Hallervorden as to the cause of increased secretion when it occurs. Again, Weber (26) failed to find any increased excretion of ammonia by sheep in which fever was induced by the use of glanders

toxin. It is noteworthy that the animals were taking plenty of food and were digesting it well, so that their livers were probably in good working order. It is, however, agreed that in herbivora the fixed alkalies are the important regulators of alkalinity.

Conclusions.—1. The effect of fever is to increase the excretion of ammonia, both absolutely and in relation to urea, as compared with the excretion of a normal man on the same diet, and this increase may survive the fall of temperature.

2. The evidence that this increased excretion is directly related to increased production of acids, or serves any useful purpose other than to facilitate the excretion of nitrogen is not convincing.

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On the Excretion of Phosphorus and of Free Acid.

Physiological variations.—In health the output of phosphoric acid by an adult man averages about 3·5 g. (P_2O_5) in the urine, and ·5 to 1·0 in the fæces, but it varies much with diet. Zuelzer (1) has shown that its variations are not necessarily parallel with those of nitrogen, as was once supposed. It has been demonstrated by Winter, Mosler, Haxthausen, and J. Vogel (2) that its excretion is small in the morning and large in the evening. Zuelzer has pointed out that these changes are not only absolute but also relative, those in urea being less marked, and Edlefsen (3) has confirmed this observation. Quite similar variations occur in the excretion of free acid, a point noted by Vogel, Beneke (4), Quincke (5), Haig (6), and Hopkins (7); in fact, the early reduced acidity and later increase therein represent the diurnal ebb and flow of the tide of phosphate excretion, and are only remotely affected by meals, just as urea is affected. It is therefore important to distinguish the morning ebb from that post-prandial alkalescence, noticed first by Bence-Jones, to which the term "alkaline tide" was applied by Roberts (8), and for which this title should be exclusively reserved. Görges (9) long ago distinguished between the two, and showed that the morning alkalescence appeared before any food was taken. In point of fact, abstention from food accentuates it. Haig has unfortunately appropriated for this latter condition the term applied by Roberts to the other; but the two have little in common, and there is no tide of alkali in the morning, only an ebb of acid. As regards the amount of free acid excreted daily, this will depend on the indicator used; with phenol-phthaleine the mean

quantity for males is, according to Stern (10), 3·39 g., or ·046 per kilo, for females 2·84, or ·043 per kilo, all reckoned as oxalic acid. Now 5 g. of P_2O_5 in the form of acid phosphate is equivalent to about 4·1 g. of oxalic acid, so that the average acidity is commonly equal to, if not in excess of that which should be attained were all the phosphate in acid form, whereas from 40 to 60 per cent. is commonly di-basic. It follows that often there are in urine acids which do not convert di-basic into acid phosphate. Bence-Jones (11) many years ago drew attention to this fact, which, indeed, must be obvious to any who, like myself, have made a large series of parallel analyses of phosphates and acidity. In estimating acidity I titrate directly a sample diluted to 1 in 10, and take the first change of colour. Scarcely any calcium is then precipitated. Also, to prevent the injurious action of ammonium salts, I add excess of the indicator.

The hourly variations in the excretion of phosphates being much greater than those of urea, it is not surprising that the output from day to day is also more variable, so that von Noorden and Belgardt (12) state that while to obtain a condition of nitrogen equilibrium is comparatively easy, to attain equilibrium of phosphorus is almost impossible. In fever also such irregularities occur.

The effects of fever.—There are few questions in the metabolism of fever about which more diverse opinions have been expressed than that of the behaviour of phosphoric acid; moreover there is no agreement as to the effects of fever on acidity.

It will be convenient first to consider fevers about which all are agreed, namely, tertian and quartan ague. Haxthausen (13), in 1860, showed that in the acute stage of malarial fever the excretion of phosphoric acid fell. Rosenstein (14) made a similar observation, and Rem Picci and Bernasconi (15), Freund (16), Terray (17), von Limbeck (18), von Moraczewski (19), and Hitzig (20) are agreed upon this point. Moreover it has been shown by von Limbeck, and also by Hitzig, that the fall in this excretion may commence before the rise of temperature, and by Freund that this fall is not prevented by previous

administration of sodium phosphate, though the latter may have been excreted freely before the attack.

According to Freund, phosphates may vanish from the urine entirely. With the fall of temperature it is agreed that increased excretion occurs, and, indeed, the output may more than balance the previous diminution, so that the twenty-four hours' excretion is often in excess of the normal. This post-febrile rise is, according to Rem Picci and Bernasconi, independent of the taking of food, just as the previous fall is independent of abstention from it; it may be precipitated by treatment with quinine. The picture presented by phosphorus metabolism in these short malarial fevers is therefore singularly uniform and complete. In chronic cases, however, the above characters are not preserved. When we turn to other fevers the pleasing unanimity recorded above disappears quickly. Heller (21) (1847) stated that the excretion of phosphates was increased in inflammatory conditions with the exception of nephritis, while Haxthausen found that in acute diseases it was diminished, as did also Bence-Jones (11). Parkes (22) stated that it was generally increased in fevers, and Riesenfeld (23) found that in relapsing fever the excretion of phosphoric acid rose at once and considerably with the rise of temperature, and fell with the fall thereof. Wyss and Bock (24), on the other hand, found in the same fever little increase, the excretion varying principally with the changes in the urinary water. Gee (25), in scarlet fever, found that for the first three or four days the excretion was unaltered or slightly increased, but was notably diminished on the fourth or fifth day, remaining low for a time and subsequently returning to the normal. Brattler (25), again, found increased excretion in fever, but J. Vogel (3) diminution, especially early in the attack, followed by a gradual rise; in fact, exactly the opposite to Gee's experience. Vogel, however, acknowledged that this diminution was not constant, and, indeed, recorded a case of pneumonia where the output of phosphoric acid was quite inordinately large, amounting on one day to 8·4 g.

P_2O_5; this patient was being treated with large doses of digitalis, and he recovered. Vogel attributed the small excretion to the low diet, and observed that with improvement in the latter it increased. These results of Vogel seemed scarcely to agree with those of Salkowski previously published on the excretion of potassium, and naturally provoked criticism. Schulte (27), at Beneke's suggestion, carried out a number of analyses on febrile cases, and found that while the phosphates of the earths were diminished, those of the alkalies were on the contrary increased. Zuelzer (28), collecting analyses already published and adding his own, found that while there was an absolute increase in phosphoric acid excretion in fever, yet it was decreased as compared with that of nitrogen, and in all his work he attached much importance to this ratio. During early convalescence, on the other hand, the largest absolute, if not relative secretion occurred. His conclusion was that during the acute stage there was a retention of phosphoric aid. This dictum of Zuelzer has received wide acceptance, and is repeated by Samuel (29) in his article on fever. Nevertheless, no agreement is found amongst later workers. Baginski (30) found that in children with pneumonia fever had little effect on the excretion of phosphorus, while von Jaksch (31) records cases of this disease, also in children, where it was notably increased, sometimes even out of proportion to the total nitrogen. Hallervorden (32) has found a large increase, especially in relapsing fever, quite in proportion to that of nitrogen, and falling with the fall of temperature more than the latter. Again, Robin (33), in cases of variola, found both in the primary fever and in the suppurative stage a large excretion of phosphoric acid, averaging for adults 3·35 daily as against 33·50 g. of urea, while after the fever the averages were 1·34 and 18·9 respectively. The phosphate was, therefore, not only absolutely but relatively, much higher during the fever than in convalescence; in fact these results are diametrically opposed to those of Zuelzer. Edlefsen (34) agreed on the whole with Zuelzer

as to the behaviour of phosphoric acid in fever, but found that it underwent curious fluctuations, which did not, however, display that regularity which Gee recorded as occurring in scarlet fever. Cario's (35) results agree fairly well with Zuelzer's, though occasional sudden variations are observable, not obviously due to variations in temperature, and unaccompanied by similar change in the output of nitrogen. Freund (16) has found that complete disappearance of the urinary phosphate may occur, not only in malaria, but also in pneumonia, and in tonsillitis with suppurative adenitis. In four cases of pneumonia this was noticed on the day of admission, in the case of tonsillitis shortly after a rigor. No quantitative analyses were made, nor had phosphate been given previously, as was done in a case of malaria. Schwarz (36), in a fatal case of tetanus, found the excretion of phosphorus to vary considerably; it was at times much increased both absolutely and relatively, the maximum attained being 4·27 g. with relation to nitrogen of 25·6 per cent. He attributed this occurrence to the special action of the tetanus toxin on the nervous system. After each injection of antitoxin a decided fall occurred in the above excretion, which was not accompanied by a similar fall in nitrogen, so that the ratio to the latter was notably altered. Von Noorden and Belgardt (12), in a case of acute rheumatism, when the diet was analysed and phosphoric acid estimated in the fæces as well as the urine, found a daily retention of phosphorus. Von Limbeck (37) found a large excretion in a case of pneumonia, especially at and after the crisis; in erysipelas, however, a very small excretion until after the fall of temperature, but in this case the loss in the fæces during the fever averaged 1·99 g. per day, and after it only ·36 g. In morbilli and phthisis the excretion was small throughout. Hutchison (38) found that in pneumonia the phosphoric acid was slightly increased, falling after the crisis to rise again about the third or fourth day of convalescence. Von Moraczewski (39) has made a special study of phosphorus matabolism not only in fever but in

other conditions; further, he has been careful to regulate the intake and to estimate the loss by the fæces as well as by the urine. Most of his work on fever has been done on cases of pneumonia, and briefly his results are as follows. Speaking generally phosphorus behaves like nitrogen, its excretion is increased during fever, and yet more after the crisis, and its variations run on the whole parallel with those of the latter. Only rarely is a retention of phosphorus discoverable when the intake and output are compared, and in such a case the loss of nitrogen will probably be small; generally there is a loss of phosphorus. As with nitrogen so here the excretion is little influenced by diet, and phosphorus given as calcium phosphate is retained. Nevertheless the ratio of P to N in the excretions in fever is not that which is found in the food, the latter being as 1 to 5—10, while the former only as 1 to 10—20. By giving sufficient doses of sodium chloride the proper ratio may be restored. The cause of this result has been already discussed. On the other hand, Cecone (40) has found the excretion of phosphoric acid not only relatively but absolutely low in conditions of high fever associated with dyspnœa, notably pneumonia. Unfortunately I have seen only a short abstract of this paper, and can give no details. Experimentally Noël Paton, Dunlop, and Macadam (41) saw no increased excretion of phosphorus in fasting dogs in which fever was produced by injection of dipththeria toxin, in fact the output was less than that by the same animals when fasting without fever, in spite of the fact that there was a decided rise in the excretion of nitrogen, and particularly of that not in the form of urea. There was thus a total lack of correspondence between extractives and phosphoric acid. On the other hand, very different results have been obtained by Dmitriewski (41) with dogs also, and either starved or fed. He used cultures of *B. pyocyaneus*, of *B. coli communis*, and also diphtheria toxin; in all cases an increase resulted in the excretion of nitrogen and phosphorus, and though the rise in both was largest with the two cultures, that of phosphorus was relatively

greater as compared with nitrogen when the toxin was used—nitrogen rose 21·4 per cent. and P_2O_5 33·4 per cent., more therefore than the former. Kalinin (43), using bouillon cultures of diphtheria and of pyocyaneus bacilli, found in the latent period diminished loss of both phosphorus and nitrogen, and but a small rise with a rising temperature. Weber (44) observed a small increase in the excretion of phosphoric acid by sheep in which fever was induced by injecting glanders toxin; a retention followed after the fever.

It is thus shown that, excepting malaria, there is no febrile complaint concerning the phosphorus excretion of which there is any unanimity, while the results of experiments on similar animals with the same toxin are diametrically opposed.

Excretion of phosphoric acid in the fæces.—As regards the excretion of phosphoric acid by the bowel in fever, von Moraczewski finds usually that it is slightly more than in health; occasionally it is considerably more. This loss, like that of nitrogen by the same route, is but little influenced by the quantity of the corresponding substance in the food.

Authors' results.—Turning now to my own work, I have carried out a considerable number of analyses, using the method of Neubauer, with a saturated solution of potassium ferrocyanide as indicator. I have also in some cases separated acid from neutral phosphates by the Freund-Lieblein process. The results represent grams of P_2O_5 in twenty-four hours, and I have grouped them like those of urea.

Cases of Scarlet Fever.

Group.	Temperature.	No. of samples.	Maximum.	Minimum.	Average of P_2O_5.	Average of $\frac{+}{U}$	Ratio $\frac{\frac{+}{U}}{P_2O_5}$
1	103° and over	20	3·90	·46	2·02	32·15	15·9
2	102°—103°	12	2·59	·73	1·69	32·46	19·2
3	101°—102°	20	4·15	·67	2·32	41·39	17·8
4	100°—101°	16	4·58	·86	2·61	45·92	17·6
5	99°—100°	9	4·92	·25	2·72	34·46	12·7
6	Under 99°	7	3·30	1·93	2·47	27·63	11·2
7	On fish or meat diet	22	4·53	1·43	2·83	31·47	11·1

On milk diet { Average of 68 samples for temperature of 100° and over, P_2O_5 2·30; average of $\frac{+}{U}$ 38·34; ratio $\frac{+U}{P_2O_5}$ 16·7.
Average of 16 samples for temperature below 100°, P_2O_5 2·61; average of $\frac{+}{U}$ 31·47; ratio $\frac{+U}{P_2O_5}$ 12·1.

Cases of Morbilli with Temperature of 103° *and over.*

Group.	Temperature.	No. of samples.	Maximum.	Minimum.	Average of P_2O_5.	Average of $\frac{+}{U}$	Ratio $\frac{+U}{P_2O_5}$
1	103° and over	6	3·17	1·72	2·58	34·81	13·5
2	102°—103°	3	2·67	·88	1·58	23·78	15·0
3	101°—102°	5	3·49	·62	2·34	30·91	13·2
4	100°—101°	3	3·16	·66	1·70	24·46	14·4
5	99°—100°	3	3·19	1·76	2·52	26·06	10·3
6	Under 99°	11	3·28	1·06	2·15	25·52	11·9
7	On fish or meat diet	18	5·02	1·34	2·56	28·70	11·2

On milk diet { Average of 17 samples for temperature of 100° and over, P_2O_5 2·12; average of $\frac{+}{U}$ 29·82; ratio $\frac{+U}{P_2O_5}$ 14·1.
Average of 14 samples for temperature below 100° P_2O_5 2·23; average of $\frac{+}{U}$ 25·64; ratio $\frac{+U}{P_2O_5}$ 11·5

Cases of Scarlet Fever (18), *Morbilli* (10), *Rubeola* (4), *Tonsillitis* (1) *taken together.*

Group.	Temperature.	No. of samples.	Maximum.	Minimum.	Average of P_2O_5.	Average of $\frac{+}{U}$	Ratio $\frac{+U}{P_2O_5}$
1	103° and over	27	3·90	·46	2·18	33·15	15·2
2	102°—103°	15	2·67	·73	1·67	31·52	18·8
3	101°—102°	25	4·15	·62	2·32	39·30	16·9
4	100°—101°	22	4·58	·66	2·66	42·61	16·0
5	99°—100°	13	4·92	·25	2·61	31·92	12·2
6	Under 99°	21	3·61	1·06	2·40	27·50	11·4
7	On fish or meat diet	50	5·02	·92	2·60	29·47	11·3

On milk diet { Average of 89 samples for temperature of 100° and over, P_2O_5 2·25; average of $\frac{+}{U}$ 36·94; ratio $\frac{+U}{P_2O_5}$ 16·4
Average of 34 samples for temperature below 100°, P_2O_5 2·48; average of $\frac{+}{U}$ 29·19; ratio $\frac{+U}{P_2O_5}$ 11·8

The excretion of the test cases on the same diet averaged 2·46 g., so that the mean result of pyrexia was that no increase occurred in the excretion of phosphoric acid by the urine. The slight diminution during the fever was probably due to increased loss by the bowel. I do not wish to insist on this conclusion, because, in view of the difficulty of establishing phosphorus equilibrium, the two test cases cannot be accepted as a standard; again, the error introduced by neglect of the fæcal excretion is much greater here than in the case of either nitrogen or chlorine, and finally, as is shown by the maxima and minima, and by examination of the tables in the appendix, wide variations occur in this excretion. Nevertheless, when we consider how much phosphoric acid there is in milk, and also remember that in many of von Moraczewski's cases the loss by fæces was not greater than in health, it is legitimate to assume that, of the products of metabolism, nitrogen, sulphur, potassium, and phosphorus, the last shows the least increase, less, as I shall presently show, than potassium, and far less than urea or uric and sulphuric acids. In fact, as already mentioned, there is a more intimate relation between the excretion of sulphuric and uric acids than between that of phosphoric acid and the same. Again, it is seen that some cases excrete more phosphoric acid early in the fever, others, and they are more numerous, later, so that the averages for all cases show an increase with a falling temperature. This is best seen in scarlet fever, in which disease a similar behaviour of urea is most conspicuous. A study of the urea ratio shows, in conformity with the results of Zuelzer, that during the fever less phosphoric acid is excreted in proportion to urea than during early convalescence; at the same time, there is no period at which phosphorus is excreted in excess, the ratios merely returning gradually to the normal. In fact, there is little indication that phosphoric acid is retained, as he supposed, during the acute stage, but rather that the disturbance in the metabolism of nitrogen produced by the fever is not

accompanied by an equal disturbance in the metabolism of phosphorus. In several cases in the acute stage a somewhat abrupt fall in the excretion of phosphoric acid occurs, unaccompanied by a similar change in urea; it is not, however, as Gee supposed, a constant phenomenon, nor characteristic of any special day, and usually it is quite temporary. The fact that in the cases H. G. B., No. 11, C. D., No. 9, and E. W., No. 2, this temporary fall accompanies an unusual excretion of sulphuric acid suggests some relation between the two occurrences; in fact, that the sulphuric acid here appropriates the available bases, and is probably united with them early in stable combination.

I have not included the cases of diphtheria in considering the effects of fever, because so little elevation of temperature occurred; it is, however, noteworthy that the excretion of phosphoric acid in the three cases of diphtheria studied was absolutely and relatively high. This point is of interest in view of the experience of Schwarz with tetanus. I would add that the large excretion of phosphate was accompanied by but small excretion of uric acid.

The cause of the anomalous behaviour of phosphoric acid in fever.—The excretion of phosphoric acid in fever presents many difficulties for which no adequate explanation has been suggested. The first anomaly is the early reduction in, or even complete disappearance of the urinary phosphate common in malaria, and found by Freund to occur occasionally in other fevers at their commencement. I have never myself observed anything of the kind. That this occurrence is not prevented by previous administration of phosphates negatives the hypothesis of von Moraczewski that it is due merely to a temporary check in the flow of phosphoric acid into the blood from the tissues. Further, such a check is quite hypothetical. Again, it is difficult to believe with von Limbeck that the phosphates are substituted for chlorides in the body, for evidence is lacking that the one can replace the

other in the economy. Another explanation which has been offered is that the kidneys are incompetent. It is in fact an old observation that inflamed kidneys are associated with diminished phosphate excretion. Heller (21), in 1849, stated that this was so, and Fleischer (45) observed that in cases of chronic nephritis retention of phosphates occurred even when they were given as such by the mouth and there was no undue loss by the fæces. On the other hand, Menarini (46) discovered that the kidney, when artificially irritated to a degree probably uncommon in fever, was quite competent to excrete phosphates given hypodermically, so that the small reduction which previously occurred in the output was probably not due to failure in kidney function. Moreover the temporary character of the retention is opposed to such an explanation. Edelfsen (34) supposed that phosphoric acid was from time to time withdrawn from the blood into the spleen and lymph-glands, where it was used for the formation of white blood-corpuscles. Von Limbeck objects to this, because in malaria there is no leucocytosis; there is, however, considerable swelling of the spleen. That increased formation of white cells may be associated with a reduction in the excretion of phosphoric acid is suggested by the results of Schwarz (36), already noted where leucocytosis following the injection of antitoxin was so attended. Further, retention of phosphoric acid has been observed by von Moraczewski in leucocythæmia. At the same time, inasmuch as phosphorus is a necessary food intimately connected with the metabolism not only of nerve-tissue but of muscle also, it is not unlikely that it is stored somewhere, like glycogen, for future use, without being immediately converted into any cell substance. Fluctuations in such a store would account for the regular diurnal variations in phosphorus excretion, and for many other anomalies therein. Further, it is known that the salmonidæ lay up considerable quantities of phosphorus against future needs. Phosphorus is found in animal tissues, according to Percival (47), in three forms, organic, inor-

ganic, and conjugated. It is noteworthy that he finds organic phosphorus to be particularly abundant in muscle, especially that most active of all muscles, the heart, while it is scanty in the thymus gland, an organ very rich in conjugated phosphorus. Retention of phosphorus does not therefore necesssarily imply either the immediate formation of nuclein or lecithin, or the accumulation of inorganic phosphates in solution. Another explanation which might account for retention in malaria is that it is indeed a renal function, but not because the kidneys are incompetent to excrete phosphate, but that they cannot do so when excreting so much chloride, just as they cannot excrete the latter when excreting excess of sulphate. At the same time, I would repeat that, except as a quite early or temporary phenomenon, there is little evidence that retention of phosphorus occurs in fever, but rather that in many fevers it is spared and not katabolised, and that this conclusion is applicable sufficiently often to show that small metabolism of phosphorus is quite consistent with the presence of considerable pyrexia. Conversely, large metabolism of phosphorus in diphtheria and tetanus may be attended with small elevation of temperature. It would therefore seem unlikely that a condition of poisoned phosphorus-holding tissue is an essential accompaniment of fever, but rather the contrary.

On the excretion of free acid.—J. Vogel (3) stated that in almost all conditions of ill-health the daily excretion of acid was diminished; he included fevers in this category, and claimed that any increase in the percentage of acid was always the result of concentration. On the other hand, Unruh (48) found increased total excretion of acid in various fevers. Little work seems to have been done on this subject, but von Moraczewski has found some increase in the acid phosphate during fever, and Pick (49) a marked diminution therein after the fall of temperature in cases of pneumonia.

My own experience is that, in absence of special disturbing factors, the excretion of free acid tends to run

parallel with that of phosphates, with, however, a slight preponderance of acid during the fever. Occasionally a large excretion of acid occurs without apparent cause, and evidently not due to acid phosphate. Grouped as before the figures for all fevers together are as follows. They represent grams of oxalic acid in twenty-four hours:

Cases of Scarlet Fever (12), *Morbilli* (10), *Rubeola* (4), *and Tonsillitis* (1).

Group.	Temperature.	No. of samples.	Maximum.	Minimum.	Average.
1	103° and over	23	8·85	1·04	2·95
2	102°—103°	12	3·39	·85	1·85
3	101°—102°	19	4·05	·85	2·25
4	100°—101°	15	4·12	·55	2·92
5	99°—100°	12	5·01	1·95	2·61
6	Under 99°	14	3·74	·62	2·02
7	On fish or meat diet	46	4·30	·46	2·37

On milk diet { Average of 69 samples for temperature of 100° and over . 2·5
Average of 26 samples for temperature under 100° . . 2·2

The average for the test cases was 1·95, having relation to the above as 1·31 and 1·17 respectively. There is thus a moderate increase, which would be decidedly less but for a few exceptional figures. The effect of fever upon this excretion is therefore not very great. The output of acid is nevertheless much in excess of that which could be ascribed to acid phosphate. A post-febrile diminution in the acidity is not conspicuous. It will be seen that I have little to say about the acid phosphate. A moderate number of estimations of it will be found in my tables, but I do not regard it as Lieblein (50) did, as a sure index of the excretion of all acid bodies, and think that the term acidity should have the same meaning when applied to urine as when applied to other solutions, and register the balance between any number of diverse acids and alkalies that may be present, as estimated directly, and always by the same indicator. The ratio between acid and neutral phosphate may be an interesting factor, but seems, in view of

the extremely small effect on acidity to phenol-phthaleine of large additions of the almost neutral monacid salt, to have little connection with the excretion of acids. The total excretion of acid phosphate is again important, but scarcely merits the term acidity. This matter is fully discussed by Hopkins (13), in his article on acidity of urine from which I quote the following sentence, "We shall do well in the present state of our knowledge to continue to employ a simple titration method, by which we obtain comparable if only relative measurements." I have throughout followed this practice.[1]

Conclusions.—1. The excretion of phosphoric acid varies greatly in different fevers, also considerably in different individuals with the same fever, and even in the same individual at different periods of the attack. These last variations follow no regular rule.

2. In the fevers here investigated its excretion is often not greatly, if at all increased, and relatively to that of nitrogen is nearly always diminished.

3. There is, however, little evidence that in these cases any retention of phosphoric acid occurs, but rather it seems that proteids rich in phosphorus escape the excessive katabolism which overtakes those proteids from which it is absent.

4. Increased excretion of phosphoric acid in fever must be regarded rather as a result of the action of a toxin on the tissues rich in phosphorus than of the influence upon these tissues of the pyrexia itself, and has little direct connection with the febrile state.

5. The excretion of free acid runs on the whole parallel with that of phosphorus, but shows rather more evidence of increase.

[1] Recently Folin (51) has maintained that more than half the acidity of the urine may be due to organic acids. This is quite in accordance with my results.

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The Excretion of Sulphuric Acid and of Sulphur in Other Forms.

Physiological variations.—The excretion of sulphuric acid by a normal man on mixed diet averages from 1·5 to 3·0 g. (SO_3), of which about $\frac{1}{10}$ is in aromatic combination. The excretion of sulphuric acid is increased by the ingestion of proteids as also by muscular exercise, and in general runs a similar course to that of nitrogen. Nevertheless the increase resulting from exercise precedes in point of time that of urea and phosphoric acid, as was first demonstrated by Engelmann, and is well shown in my own work.

The excretion of etherial sulphates depends principally on the direct introduction of aromatic bodies which combine with sulphuric acid, or the formation of such substances as a result of decomposition in the alimentary canal.

There is moreover a considerable quantity of neutral sulphur, taurin, cystin, sulphocyanides, etc., in the urine, forming about 14 to 20 per cent. or more of the total sulphur excretion. This portion is, like the inorganic sulphates, increased by exercise, while the aromatic sulphates are not.

In dogs the excretion of neutral sulphur is very considerable, and while the total sulphur varies with the total nitrogen output, the oxidised sulphur varies with urea. The relation of unoxidised sulphur to oxidised sulphur in the urine has been used by many authors as an index of the efficiency of the oxidisation processes in the body generally. For the literature on this subject I must refer readers to a paper by Benedict (1) and also to Huppert (2).

The effects of fever.—Heller (3) was one of the earliest to study this question, and found that in fevers and inflammatory conditions the excretion of sulphuric acid was increased; moreover this might occur in nephritis, though the phosphates were diminished. Parkes (4) again found the same increase in various fevers. Fürbringer (5) observed that not only was sulphuric acid excretion increased in fever, but, as compared with the excretion during convalescence, it was increased out of proportion to urea; in fact, that its behaviour was the opposite to that of phosphoric acid. The absolute excretion during fever varied between 1·81 and 3·51 g. SO_3, the normal excretion on ordinary food between 1·5 and 2·33, and on the diet of fever without pyrexia between ·86 and 1·52. The "worth" in relation to nitrogen was: in fever, 11·5—15·6 per cent.; in convalescence, 5·7—11·55 per cent.; in health, 11·3—14·7 per cent. The normal relation of sulphuric acid to nitrogen was therefore preserved in fever in spite of the diet, and fell in convalescence. Zuelzer (6) and Gruner (7) have obtained similar results. Cario (8) found the absolute excretion always, the relative usually, increased during fever, but the ratio was sometimes variable. He suggested that these variations might depend on the quantity of bile secreted and lost in the fæces.

Author's results.—I have collected my own results for various fevers and arranged them below.

Twenty-four Hours' Excretion of SO_3 in Grams for Cases of Scarlet Fever (16), *Morbilli* (10), *Rubeola* (4), *and Tonsillitis* (1).

Group.	Temperature.	No. of samples.	Maximum.	Minimum.	Average of SO_3.	Average of $\frac{+}{U}$	Ratio $\frac{+}{SO_3}^{U}$
1	103° and over	27	4·22	1·26	2·54	33·15	13·1
2	102°—103°	15	3·26	·99	2·16	31·52	14·6
3	101°—102°	25	4·03	1·30	2·79	39·30	14·1
4	100°—101°	22	5·19	1·14	3·03	42·61	14·1
5	99°—100°	13	3·53	1·02	2·21	31·92	14·4
6	Under 99°	21	3·81	1·25	1·76	27·50	15·6
7	On fish or meat diet	50	5·64	·97	2·28	29·47	12·9
On milk diet	Average of 89 samples for temperature of 100° and over, SO_3 2·67; $\frac{+}{U}$ 36·94; Ratio $\frac{+}{SO_3}^{U}$ 13·8.						
	Average of 34 samples for temperature under 100°, SO_3 1·93; $\frac{+}{U}$ 29·19; ratio $\frac{+}{SO_3}^{U}$ 15·1.						

The excretion of the test cases averaged 1·29 g., having relation to the above of 1 : 2·07 and 1·50 respectively. The behaviour of sulphuric acid is therefore in sharp contrast to that of phosphoric. The ratio of the former to urea in the test cases was $\frac{+}{SO_3}^{U} = 16·8$. Even with the fall of temperature this relation is not attained, while with high fever the ratio on the milk diet is practically the same as that of a normal man on a diet of meat. My results therefore agree completely with those of Fürbringer.

The effects of fever on the excretion of neutral sulphur.—Salkowski found the neutral sulphur in a case of pneumonia to amount to 20 per cent. of the total. Voirin and also Reale and Velardi (10) have found relative increase in this excretion in the febrile state. Benedict (1) finds that this is not constant, yet in a case of pneumonia just before the crisis the neutral sulphur formed 55 per cent. of the total. During convalescence this excretion is both absolutely and relatively very small, this condition accom-

panying retention of nitrogen. Benedict does not agree with the opinion of several authors, to whom reference is given, that neutral sulphur is a measure of the metabolism of organised albumen, nor with that of others that its increase indicates defective oxidation. He considers that it is a product of a special part of the cell, resembling in this respect the alloxur bases, and that the metabolism of which it is index is, like that producing the alloxur bases, but little dependent on the destruction of albumen generally, whether of the food or of the tissues. He has, however, to acknowledge that some part of the neutral sulphur must be regarded as an intermediate body oxidisable to sulphuric acid, and that this moiety is increased by various narcoses, while it is diminished by increased consumption of fats. It must be mentioned that Benedict produces no parallel analyses of uric acid and neutral sulphur; further, inasmuch as the absolute dependence of uric acid excretion on nuclear metabolism is by no means finally settled, parallelism between the two excretions might bear a very different interpretation to that suggested by this author.

The excretion of aromatic sulphates does not appear to be influenced by the febrile condition as such.

Conclusions.—1. The excretion of sulphuric acid in fever, when compared with that of a normal man on the same diet, is increased both absolutely and in relation to urea.

2. The excretion of neutral sulphur is frequently increased also.

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5. FÜRBRINGER.—Virchow's Arch., Bd. lxxiii, S. 39, 1898.

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7. GRUNER.—("Die Ausscheid. d. SO_3," Giessen, 1852). Quoted by Cario, 8.

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On the Excretion of Potassium.

Physiological variations.—The excretion of potash by the urine averages for an adult on ordinary food between 2·3 to 3·9 g. (K_2O) in the twenty-four hours. While considerably affected by change of diet, it is much less so than is that of soda, resembling in this respect phosphoric acid. It is largest when meat is taken, but is nevertheless considerable when the food comprises much milk though no meat. Thus a case of progressive muscular atrophy on "an abundant diet with milk, but no meat" excreted on an average during three days 3·452 g. (K_2O), on a meat diet, during six days an average of 3·654 g. These figures are Salkowski's (1, *a*). This result is not surprising, for cow's milk is comparatively rich in potash and phosphorus, though poor in nitrogen, the proportions of each being about ·17 per cent. K_2O and ·18 per cent. P_2O_5 to ·53 per cent. N, or approximately one of either of the first two to three of the last. Meat contains on an average ·45 per cent. K_2O, and ·46 per cent. P_2O_5, with 3 per cent. N, or one of each of the two first to seven of nitrogen. The value of the milk diet of the hospital is about 3·18 g. K_2O.

The relation of K_2O to P_2O_5 in the urine of twenty-four hours is given by Huppert (2) as the result of five analyses, and his figures, if calculated as K_2O and P_2O_5, yield 3·113 of the former to 3·033 of the latter, or about 1 : 1, and the ratio of either to urea will be about 1 : 10, while that of SO_3 to the same is about 1 : 13. These figures agree well with what is known of the average excretion of these substances. Salkowski gives figures for the excretion of potash on the diet for fever which average but ·765 g. K_2O, but the patient was a melancholic female whose average output of urea was but 8·31.

My own figures are higher, and average 1·66 g. K_2O to 2·46 P_2O_5, 21·19 urea, and 1·29 SO_3.

The excretion of potash by the bowel is in health rather in excess of that of sodium, but nevertheless inconsiderable. The average of five days on normal diet was found by Salkowski to be ·27 g. K_2O. If, however, diarrhoea occurs, as in typhoid fever, the loss may exceed that by the urine (Salkowski).

Loss by other routes.—The sweat of a man contains very little potassium, the saliva, however, much. Salivation may therefore cause a decided loss of potash.

The loss by the sputum, *e. g.* in pneumonia, is negligible (Salkowski).

The effects of fever.—The excretion of potassium in various febrile conditions has been studied by Salkowski (1), von Limbeck (3), and von Moraczewski (4); in malaria by the latter and Rem Picci (5); there have also been published a few analyses by Zuelzer (6). The cause of this comparative dearth of facts, which is accentuated by the yet greater deficiency in simultaneous analyses of the acids, is doubtless that given by Salkowski himself, who has done most to remedy it. It is the very large expenditure of time and labour demanded in the analysis, and, I would add, the heavy cost in this country of strong alcohol and pure ether, and the extreme and ever-increasing price of platinum. Very early in my work I arrived at the conclusion that some process must be devised which would be much simpler, more rapid, and less expensive, or else I must abandon what promised to become an interesting part of my research. My process, which has been published already, combines all the above advantages with, if the quantity of urine available be not limited, sufficient accuracy. It is, however, desirable to carry out the analysis in duplicate and take the average. This I have usually done, so that the recorded figures represent in general the averages of two analyses carried out side by side simultaneously. The labour thus entailed is not great, and cannot be compared with that involved in a single analysis by any direct method, while the cost is

negligible as regards reagents. In this way I have been enabled to include in my analyses bases, acids, and nitrogenous ingredients to an extent that would have been otherwise entirely beyond my powers.

Returning now to Salkowski's classical work, we find, if we exclude cases of typhoid, a disease in which the urinary potash is often low, six series of analyses on pneumonia, and one series each on relapsing fever, typhus, and erysipelas. Of these the figures representing days of fever amount to thirty, the maximum (excluding milligrams) is 4·32 g., the minimum ·73, and the average 2·11, all reckoned as K_2O. If we omit the case of erysipelas there would remain but two samples which yielded 3 g., while if the typhoid cases were included the average would yet be more reduced. The excretion of potassium, as found by Salkowski, rarely therefore attains that of a normal man on ordinary food, or on an abundant diet with milk and no meat, and its average does not greatly exceed that found by myself on a fever diet without fever. As compared with the excretion of nitrogen, it is in consequence as a rule decidedly diminished. I wish to emphasise this point because too much importance has, I think, been attached to increased excretion of potassium in fever. After the fall of temperature the excretion in most cases fell below that normal for the diet, but this phenomenon was not constant. Thus while conspicuous in four of the pneumonia cases, it was absent in another and scarcely observable in the sixth. It was absent in the case of erysipelas, and was not looked for in the case of typhus nor yet in those of typhoid. In a subsequent paper, however, Salkowski studied the excretion of a case of the last disease during fifteen days of fever and seven days thereafter; the average excretion of urea during the fever was 33·90 g., of potash (K_2O) 1·41; ratio 24·0 : 1. After fever the urea averaged 22·20, the potash ·92; ratio 23· 7 : 1. The output of potassium during fever was therefore on an average less than my figure for a normal man on fever diet, and it was less in proportion to urea then than

subsequently. The small excretion of potassium in typhoid fever, which is shown also by von Moraczewski, is probably correlated with the small output of phosphoric acid in the same disease. The average of fifty-four post-febrile samples in Salkowski's earlier paper is 1·36 g. The cause of the post-febrile diminution when it occurs is doubtless inanition. It is not connected very directly with the previously increased excretion, for, as I shall presently show, it is commonly absent in well-nourished patients who take their food well, in spite of previous high fever accompanied by considerable excretion of potassium. Von Limbeck's results scarcely agree with Salkowzki's, for in two cases of phthisis, one each of morbilli and erysipelas, and one of pneumonia, the only large excretion of potash, and it is but 2·886 g. K_2O, occurs on the last day of the fever in pneumonia; in morbilli, phthisis, and erysipelas it is uniformly low, and less than the sodium. In malaria, on the other hand, a large increase of both occurs. Von Moraczewski's cases comprise one each of malaria, pneumonia, and phthisis, and two of typhoid, of which, however, only one was regularly investigated. The work was carried out with extreme diligence, the food, the fæces, and almost every possible constituent of the urine being submitted to analysis. Somewhat curiously, and in connection with our present topic unfortunately, sulphuric acid was alone omitted. In the case of typhoid where daily analyses were performed the excretion averaged but ·76 (K_2O) by the urine and ·46 by the fæces, and examination of the intake showed a retention of about 2 g. daily throughout the eight days, some febrile, some afebrile, which comprised the period of the investigation. In the case of pneumonia the hourly excretion during eighteen hours before the crisis, this being the first figure recorded, is but ·0385 g. K; it rose at once with the fall of temperature to ·1433, and thereafter averaged ·076. Reckoned as K_2O for twenty-four hours, the numbers would be about ·99, 4·14, and 2·2 respectively. There was a loss of potassium on the balance throughout, but it was greatest

after the fever, not only absolutely but in relation to urea. This result differs considerably from those of Salkowski in the same disease. A case of phthisis with hectic fever showed a quite insignificant increase in the excretion of potassium with the rise of temperature. In malaria potassium and sodium rose together.

As regards the relation of potassium to phosphoric acid, von Moraczewski could find no correspondence between them; nevertheless, some relation can be traced. For instance, the small anti-critical excretion of potassium in his case of pnuemonia was attended by a similarly small output of phosphoric acid, and the maximum of each followed immediately after. Again, the typhoid case referred to excreted but little of both these substances. Moreover in fever artificially produced in dogs Noël Paton, Dunlop, and Macadam found a reduction in the excretion of both alike.

Author's results.—Passing now to my own figures, and excluding cases where the patient was at the time, or had within thirty-six hours, been taking salts of potash or large doses of salicylate, I have collected numbers representing ninety-two twenty-four-hour samples and grouped them as follows:

Excretion of K_2O in Twenty-four Hours by the Urine.

Group.	Temperature.	No. of samples.	Maximum.	Minimum.	Average.
1	102° and over	17	5·65	·99	2·50
2	101°—102°	16	4·81	·65	2·34
3	100°—101°	12	4·38	1·60	2·69
4	99°—100°	9	5·26	·40	2·14
5	Under 99°	9	5·40	1·00	2·77
6	On fish or meat diet	29	5·02	1·21	3·05
On milk diet	Average for 45 samples with temperature of 100° and over				2·49
	Average for 18 samples with temperature under 100°				2·45
	Average of the test cases 1·66; ratio of this to the above 1 : 1·5.				

These excretions are the largest yet recorded, and correspond with the generally high level attained by urea and sulphuric acid. The large output of nitrogen is

doubtless chiefly due to the patients being for the most part well-grown adults, well nourished previously, and with high fever. The circumstances of patients admitted to the London Fever Hospital are, in fact, superior to those of patients at general hospitals. The large output of potassium is presumably due to some extent to the same cause, partly also perhaps to the free use of milk, and is doubtless directly related to the large excretion of acids. Further, it is noteworthy that, probably for similar reasons, and also because solid food was commonly added at once with the fall of temperature, a small post-febrile excretion is by no means a constant feature; sometimes, indeed, as in von Moraczewski's pneumonia case, it is replaced by excess, and where it occurs it is in general so transitory that it affects the averages but little. In short, it is not characteristic of the post-febrile state, but merely of previous malnutrition. Again, it is shown that the excretion of potassium may undergo considerable, and sometimes sudden variations, which are better seen in the complete charts; and lastly, that these variations are in general accompanied by similar fluctuations in the excretion of phosphoric acid.

I will now place side by side with the figures just given those representing the urea phosphoric acid and sulphuric acid of the same samples, and also the averages of these. I do not include in these averages the urea and acids which belong to the many cases where potassium was not estimated.

Group.	Maximum.				Minimum.				Average.			
	K_2O	P_2O_5	SO_3	+ U	K_2O	P_2O_5	SO_3	+ U	K_2O	P_2O_5	SO_3	+ U
1	5·65	3·90	3·80	32·25	·99	1·24	1·26	11·80	2·50	2·34	2·59	32·13
2	4·81	3·64	2·59	37·18	·65	·91	2·06	30·75	2·34	2·32	2·71	39·23
3	4·38	2·65	5·19	85·50	1·60	1·41	2·78	48·30	2·69	2·56	3·20	47·37
4	5·26	4·48	2·39	39·55	·40	·25	1·02	13·90	2·14	2·38	2·04	31·00
5	5·40	2·73	4·80	81·40	1·00	1·90	2·18	38·70	2·77	2·85	2·81	41·90
6	5·03	3·78	2·70	40·74	1·21	2·02	2·00	31·20	3·05	2·99	2·46	32·86

It appears that while, speaking generally, a large excretion of urea is accompanied by a large excretion of

the other ingredients, yet the correspondence between phosphoric acid and potassium is closer than that of sulphuric acid therewith. On the other hand, there is more distinct relation between the latter acid and urea than between either potassium or phosphoric acid and the same.

These relationships are further illustrated by the following table of averages:

On fever diet without fever	SO_3 1·29 K_2O 1·66 P_2O_5 2·46	+ U 21·69.	Ratio	1 : 16·8 1 : 13·0 1 : 8·8
Temperature of 100° and over, on same diet	SO_3 2·80 K_2O 2·49 P_2O_5 2·39	+ U 38·90.	Ratio	1 : 13·9 1 : 15·6 1 : 16·3
Temperature below 100°, on same diet	SO_3 2·42 K_2O 2·45 P_2O_5 2·61	+ U 36·45.	Ratio	1 : 15·1 1 : 14·9 1 : 14·0
After return to fish or meat diet	SO_3 2·46 K_2O 3·05 P_2O_5 2·99	+ U 32·86.	Ratio	1 : 13·3 1 : 10·8 1 : 11·0
Normal urine	SO_3 2·2 K_2O 3·0 P_2O_5 3·0	+ U 30·00.	Ratio	1 : 13·2 1 : 10·0 1 : 10·0

With a temperature of 100° and over, sulphuric acid greatly exceeds its normal quantity in relation to urea for the diet, and approximates its proportion for ordinary food. Phosphoric acid, as before mentioned, exhibits the contrary behaviour, being below its proper proportion even for ordinary diet, and much below that for the diet of fever. Potassium occupies an intermediate position, but more closely resembles phosphoric acid, being excreted in smaller than the proper quantity in relation to nitrogen. This result is in agreement with those of von Limbeck, Salkowski and von Moraczewski. As the temperature falls, a return to the normal relations is gradually brought about, and is attained when the patient again takes ordinary food. In the interval the abnormal relations are never reversed; there is therefore no indication here

that potassium any more than phosphoric acid is retained, but merely that there is less metabolism of these than of nitrogen and sulphur, nor is the reduced excretion of potassium in relation to urea in any way characteristic of the post-febrile state, on the contrary it is, on the average in my cases, as in that of Salkowski previously quoted, more marked when the temperature is above 100° than when it is below it. The significance of this fact becomes greater when we study the relation of potassium to sulphuric acid and to acidity. It then appears that an excretion of potash out of proportion to phosphate is in general brought about by an abnormal output of sulphuric acid and sometimes of free acid. Thus we find H. G. B., No. 11, excretes 5·65 g. K_2O with but 3·90 g. P_2O_5, again 1·29 g. with but ·75 g. P_2O_5; the SO_3 is in the first instance 3·80, having relation to urea as 1 : 8·5, while acidity is altogether abnormal, 8·85; in the second instance SO_3 is 3·70. H. C. M., No. 13, passes 4·38 g. K_2O to only 2·65 g. P_2O_5, and again 5·40 to 2·73; here SO_3 is 5·19 and 4·80. V. R. G., No. 12, shows 1·38 K_2O, ·73 P_2O_5 and 2·02 SO_3. In short, the excretion of potash is influenced by both acids, and seems to me to play a far more important part in neutralising them than does ammonium. Nevertheless the fact remains that, in spite of these occasional anomalies, the parallelism between potassium and phosphate is distinctly conspicuous, and von Moraczewski's failure to observe it depends partly on his neglect to study sulphuric acid and the disturbance of relations brought about thereby, and partly on the limited number of his analyses of the two bodies concerned. A further example of the close relation between these two is shown by C. D., No. 9, who, as a result of a large dose of salicylate of sodium excreted 5·85 g. K_2O with 4·92 P_2O_5 one day, and 4·34 K_2O and 3·39 P_2O_5 on the next. As an instance of how completely the normal relation between P_2O_5 and K_2O may be disturbed by a large excretion of SO_3, I would quote again my own work on the effects of exercise. I have shown that the remarkable

excretion of SO_3 which occurs in the first two hours after violent exercise is accompanied by a similar excretion of K_2O, and all parallelism between the latter and P_2O_5 is lost. Here also K_2O seems to play a far more important part in regulating alkalinity than does ammonia. An instance of the converse kind is shown by F. J., No. 25, where 3·27 g. of SO_3 and 3·34 g. of P_2O_5 produce but 2·49 of K_2O, because a sudden return of Na_2O occurs without corresponding return of chlorine. A similar result occurs in von Limbeck's pneumonia case, where, in spite of the excretion of 3·64 g. of P_2O_5 and 2·48 g. of SO_3, K_2O falls from 1·276 to ·334 because an abrupt return of sodium occurs with the minimum excretion of chlorine. Ammonia is much less reduced by this occurrence. In F. J., however, there was no fall in the potassium, it merely did not rise sufficiently to balance the acids.

Why is the excretion of potassium increased in fever? The conclusion which I draw from the above and other figures is that the increased excretion of potassium in fever is only in part the result of increased metabolism, the remainder being probably drawn from some store within the body and used to correct excessive production of acid, and that in consequence the destruction of those tissues which contain phosphorus and potassium is more accurately gauged by the excretion of the former than that of the latter. I find moreover, as I have said in discussing phosphoric acid excretion, little reason to suppose that any retention of phosphoric acid occurs except as a quite temporary phenomenon and in small quantity only. It would therefore appear that in the fevers here studied, and in cases which, in spite of high temperature, end in recovery, the organism, because its stores of carbohydrates are soon exhausted, is indeed compelled to burn up nitrogenous material more extensively than usual, but it is, after first consuming its glycogen, able to select what nitrogenous material it will use, and to choose those proteids which are rich in sulphur and nitrogen, and to spare those rich in potassium and phosphorus. Whether this

metabolised proteid has or has not first become an integral part of the living tissue need not here be considered; in either case it is the less essential and permanent substance which is chiefly consumed, while the products of the disintegration of the more important parts of the structure may be scarcely more than might be attributed, as in exercise, to the mere wear and tear of the machine in the work of metabolising so actively the other matter. In a word, the important elements of the living cell are not poisoned in such fevers, they are merely overworked. Fever may, indeed, be in these diseases, at least when progressing favourably, but a carefully regulated and orderly reaction of the undamaged tissues, deliberately brought about to prevent the injurious influence of a poison, and not the direct effect of such poison upon them. Damage may and commonly does occur, but it need not be either the result or the cause of the febrile movement, and it is often most conspicuous where this movement is small or entirely absent. This matter is discussed in a paper by Löwy and Richter which I have already referred to in connection with the alkalinity of the blood, also by Hale-White in his Croonian lectures.

On the relation of potassium to sodium in the urine of fever.—Salkowski showed that the excretion of potassium tended to be high in fever and low in convalescence, while sodium behaved conversely. It must not, however, be concluded that the minimal output of potash necessarily coincides with the often abrupt increase in the soda. Salkowski himself is careful to point out that such a coincidence is by no means invariable—that the potassium may in fact be already rising when sodium rises, or may be still falling after this occurs. My results show that an abnormally small excretion of sodium during fever is a far more constant phenomenon than abnormally small excretion of potassium after it, and, indeed, that the latter has probably little direct connection with the febrile state, while the former is a highly characteristic and important feature of it. The return of the sodium is in consequence

as a rule unaccompanied in my cases by any conspicuous fall in the excretion of potassium.

On the effect of administering salts of potassium in fever.—I have already pointed out that while salts of sodium, such as the chloride and the citrate, when given to febrile patients cause no or little change in the excretion of this metal, potassium given as citrate is excreted freely. The same result is obtained if the iodide is given, as is shown by the case M. I., No. 27.

Conclusions.—1. There is increased excretion of potassium as a result of fever, and this increase not rarely survives the fall of temperature.

2. The extent of this increase depends partly on the output of sulphuric acid and partly on the amount of tissue rich in potassium which is metabolised.

3. The portion attributable to this latter may be measured by the excretion of phosphoric acid, and is small as compared with the output of nitrogen in the fevers here studied.

4. The organism in some fevers is able to select for combustion those proteids which are rich in nitrogen and sulphur, and to spare to a large extent those rich in potassium and phosphorus.

5. It is therefore possible that the unusual metabolism of the latter is here due rather to voluntary overwork than to passive dissolution under the influence of some circulating poison.

6. An abnormally small excretion of potassium after fever is probably due to previous malnutrition during the attack, and is a far less constant phenomenon than an abnormally small excretion of sodium while the fever lasts.

7. Potassium cannot replace sodium in the performance of those functions for which the latter is retained in the febrile state.

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On the Excretion of Calcium.

Physiological variations.—F. Voit (1) has made a careful study of this question, and the following notes are taken from his paper:—Only a small portion of the calcium taken by mouth is absorbed, and, of that which enters the circulation, much is again excreted into the bowel and removed in the fæces and not in the urine. The circulating calcium is probably an albuminate, and its quantity can be only slightly increased by a diet rich in calcium. By a diet poor in calcium the organs, not only the bones but others also, are induced to give up calcium to the blood. According to von Noorden and Belgardt (2), the calcium which appears in the urine amounts to between 4 and 29 per cent. of the intake, and averages 14 per cent. thereof. Hoppe Seyler (3) has shown that the effect of rest in bed is to increase the urinary calcium, but whether or no this is at the expense of that of the fæces does not appear. After a time the excretion falls again to the normal without change in the conditions. Muscular exercise may, according to Kaup (4), diminish this excretion, as also that of phosphoric acid. It is not greatly influenced by food, for, as above mentioned, large additions to the diet are very imperfectly absorbed, and, on the other hand, in inanition the excretion, as I. Munk (5) has shown, remains relatively high. Normally the urinary calcium averages for an adult ·2—·4 g. (CaO) in the twenty-four hours. On the milk diet of the hospital my test case produced ·39*g*.

The effects of fever.—Heller (6) observed that in inflammatory conditions accompanied by exudation the phosphates of the earths were remarkably diminished in the urine, reappearing, however, with absorption of the exudate; they were decreased also in nephritis, but increased in endocarditis, in brain disease, and, above all, in acute rheumatism. Schulte (7) found the earthy phosphates diminished in the urine in febrile patients. Senator, (8, *a*) studying the excretion of calcium and indican, found that in cases of fever the latter was increased, the former diminished; an exception, however, occurred in the case of pleural effusions, where the output was increased in spite of fever. In further observations (8, *b*) Senator has found in cases of phthisis a large excretion of calcium in spite of low diet. He referred this to the presence of an abnormal quantity of calcium in the lungs of such cases. The calcium, he supposed, came originally from the bones, which undergo unusual metabolism, and the suppurating focus in the lungs is a temporary resting place for it. Zuelzer (9) has observed that in fevers calcium is markedly diminished in the urine as compared with nitrogen, more so in fact than is magnesium, while in convalescence both again increase. Baginski (10) found very little calcium in the urine of a child with pneumonia. Neumann (11), again, has found diminished excretion in the febrile state. Von Noorden and Belgardt (2) insist on the necessity of studying not only the urine but also the food and the fæces in considering the metabolism of calcium, and they find in a case of acute rheumatism with effusion into the joints an average daily loss of ·42 g. of calcium and ·14 g. of magnesium, though ·42 g. of P_2O_5 was retained daily. They thus confirm the observation of Heller with regard to this disease. In two cases of osteo-arthritis, on the other hand, there was retention of all the above substances. Von Limbeck (12) has found in two cases of phthisis no increase in the excretion of calcium, whether by the urine or the fæces. In a case of pneumonia it was entirely absent from the urine until the temperature fell; it then

returned gradually, while in a case of erysipelas it was present in very small quantity throughout. In the last case the calcium of the fæces was estimated during three days with and three days without fever; the totals were—5·05 g. and 2·35 g. CaO. Von Moraczewski (13) has made a special study of calcium metabolism in anæmia (*a*), leucocythæmia (*b*), diabetes (*c*), and the febrile state (*d, e, f, g*), and has always checked the output in the urine by that in the fæces as well as by the intake. Briefly his results in fever and in most conditions are that calcium tends to behave in the same way as chlorine. In fever, therefore, there was retention until the temperature had fallen and thereafter a slow return to the normal excretion. Further, calcium given as phosphate, $Ca_3(PO_4)^2$, in doses of 5 g. daily was assimilated, causing little increase in the output either by the urine or the fæces, about 80 per cent. of what was taken being retained. Less calcium than usual was lost by the fæces in fever, so that its relation to phosphoric acid therein was changed—instead of forming, as in health, normal phosphate, it was found as the mono- or even di-hydrogen salt. Large doses of sodium chloride promoted the excretion of calcium, as of phosphorus and nitrogen, but moderate doses had none of these effects. In fever, as in anæmia, the tissues were found to be rich in chlorine but poor in phosphorus and calcium. The parallelism between chlorine and calcium was therefore lost here. In diabetes there was a loss of calcium, chlorine, and phosphorus, even when nitrogen equilibrium was maintained. The condition was therefore the opposite to that in fever. Von Moraczewski's results with the administration of calcium phosphate are certainly most remarkable, considering that so much work has been done on this subject, and all workers are agreed that in health the bulk of the calcium given in any form by the mouth is not assimilated. Further, von Limbeck's figures show that, in absence of any addition, more calcium was lost by the fæces in fever than thereafter. A curious fall in the excretion of calcium and increase in its retention was

observed by von Moraczewski just before the crisis in pneumonia.

Author's results.—My own work on this subject is so small that a few words will suffice for it. I have estimated calcium, in the urine only, in two cases of scarlet fever, G. B—, No. 14, and W. H—, No. 18, and one of morbilli, F. J—, No. 25. The figures are decidedly lower than that of a test case on the same diet. To make sure that this was not merely due to imperfect precipitation, I repeated the analysis of one day on the ignited residue of a fresh sample, but no more calcium was found therein. It would seem therefore that these fevers resemble the majority in their calcium metabolism, and differ from acute rheumatism, and perhaps phthisis, brain disease, and pleural effusion. It is interesting to note that Moos found no diminution of urinary chloride in meningitis, and Hutchison none in acute phthisis or pleural effusion.

The cause of retention of calcium.—Von Moraczewski attributes this phenomenon entirely to the watery condition of the organs, which he regards as the dominant factor in the febrile process. He believes that these watery tissues take up calcium phosphate as well as sodium chloride. The following facts scarcely support this contention. Firstly, moderate doses of sodium chloride given with calcium phosphate did not prevent the retention of calcium even though the chloride, the more active salt was excreted freely; secondly, this retention of calcium, like that of chlorine, continued long after the crisis in pneumonia, and therefore at a time when the tissues were probably unusually dry; thirdly, according to this author, the febrile tissues are abnormally poor in calcium. Indeed, I cannot think that these simple physical explanations are at all applicable to the complex processes of metabolism in the human body.

It seems to me more probable that such calcium as is retained, and apart from von Moraczewski's work there is no evidence that this is large in amount, is retained in

organic combination, and serves some purpose in connection with nutrition which has not yet been definitely ascertained. Calcium chloride in doses of 10 grains t. d. s. has been recommended for treatment of pneumonia by Bose (14), and von Moraczewski has used the phosphate, 5 grams daily, for the same purpose.

On the Excretion of Magnesium.

Physiological variations.—The excretion of magnesium, unlike that of calcium, takes place principally through the kidneys, and very little appears in the fæces. (Von Moraczewski, 13, *e*). That in the urine is usually about double the calcium (Hopkins, 15). It is more influenced by diet than is its companion, and sinks very low on a diet of milk. My test case excreted but ·11 g. MgO.

The effects on fever.—Heller in the work above-mentioned, as also Schulte, did not differentiate between calcium and magnesium. Baginski, in the case of pneumonia referred to, found but a trace of magnesium in the urine. Von Limbeck, in a case of erysipelas, found very little magnesium in the urine, but decidedly more in the fæces, especially during the fever. On the other hand, von Moraczewski, in a case of pneumonia, found little magnesium in the urine on the sixth day, when the analysis commenced, but increasing quantities until the crisis, after which the excretion fell. The fæces contained but a very small quantity.

My own two series of analyses (G. B—, No. 14, and F. J—, No. 25) commenced early in the disease, and show at first a very trifling excretion; towards the end of the fever there is a rise followed by a fall. The figures are throughout lower than von Moraczewski's, partly perhaps because milk diet was used. The work done on this subject so far is scarcely sufficient to allow for any conclusion. I may, however, mention that Maragliano and Robin (16) state that magnesium, like chlorine, may

disappear completely in the urine in variola, and that in such cases the prognosis is grave.

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APPENDIX.

Analytical Methods and Tables of Results.

The temperature is the highest evening temperature in degrees Fahrenheit.

Water (H_2O) is given in cubic centimetres for twenty-four hours; all other quantities, including drugs, in grams for twenty-four hours.

Milk diet is three pints of milk and one egg. Small additions, *e. g.* milk pudding, were occasionally made. Cases where this was done are excluded in the summary of chlorine results.

Analytical Methods:

Sodium (Na_2O) and potassium (K_2O) by Lehmann's process in No. 25.

By the author's modification of Lehmann's process[1] in Nos. 12 and 13.

By the author's process[1] in all others.

Chlorine (Cl.) by Mohr's process in Nos. 1, 2, 3, 4, 5. 19, 20, 21, 22, 23, 24, 29, 30, 31, 32, and 37, (Results below ·10 by this process are given as ·10).

By Volhard and Arnold's process in all others.

Total Nitrogen (N) by Kjeldahl's process.

Urea ($\overset{+}{U}$) by Hüfner's process in all except the undermentioned.

By Mörner and Sjöqvist's process in Nos. 6, 25, and 36; also in the test cases.

Uric acid ($\overset{-}{U}$) by Hopkins' process.

Ammonia (NH_3) by Schlössing's process.

Phosphoric acid (P_2O_5) by Neubauer's process.

Acid phosphate by Freund and Lieblein's process.

Acidity directly with excess of phenol-phthaleïn as indicator, the sample diluted to $\frac{1}{10}$, and the first change of colour taken.

Sulphuric acid (SO_3) by Salkowski's process.

[1] 'Journ. of Physiol.,' vol. xxviii, p. 507, 1902.

	Date.	Temp.	H_2O.	Cl.	$\overset{+}{U}$.	$\overset{-}{U}$.	Acid.	P_2O_5.	SO_3.	Drugs.	Diet.
No. 1.—A. H., ♂, 18. Scarlet fever. Admitted Feb. 7th, Discharged March 20th, 1897.	7	103·6°	592	2·13	25·46	·76	1·48	1·58	1·84	*	Milk.
	8	104·2	720	2·19	31·32	·95	4·46	2·50	2·45	*	,,
	9	103·6	706	·92	26·12	·50	6·14	1·55	1·84	*†	,,
	10	101·6	2170	·87	45·57	·82	3·47	3·04	3·26	†	,,
	11	101·0	1085	·10	33·96	·66	1·95	1·22	2·77	†	,,
	12	100·2	1593	·10	31·66	·81	2·71	2·26	2·55	†	,,
	13	99·2	909	·10	25·27	·85	3·09	2·52	2·14	—	Fish.
	14	99·0	809	·10	10·76	·52	1 06	1·43	·97	—	,,
	15	98·4	854	·94	27 93	1·12	2·05	3·20	2·16	—	,,
	16	98·0	720	2·30	21·10	·60	1·87	2·05	1·55	—	,,
	17	99·2	1232	3·57	35·11	·81	3·69	3·24	2·49	—	Meat.
Drugs.—* Spt. Ammon. Aromat. and Liq. Am. Acet. † Caffeine.	18	98·6	1060	2·28	31·59	·69	3 92	3·35	2·17	—	,,
	19	98·6	—	—	—	—	—	—	—	—	,,
	20	98·4	810	2·39	28·35	·51	3·24	2·47	2·02	—	,,
No. 2.—E. W., ♂, 21. Scarlet fever. Admitted Feb. 22nd, Discharged April 3rd, 1897.	22	103·8°	930	·98	36·73	·58	2 60	1·49	2·79	—	Milk.
	23	103·0	670	·10	31·82	·62	2·75	1·57	2·46	—	,,
	24	103·0	—	—	—	—	—	—	—	—	,,
	25	102·6	1139	·10	53·76	1·34	1·03	·97	3·26	*	,,
	26	102·0	1264	·10	33·44	·78	0	1·42	2·86	*	,,
	27	101·8	1320	·10	31·41	·94	0	1·54	2·05	*	,,
	28	100·4	1422	·10	38·25	·97	0	2·23	2·63	*	,,
	1	100·2	1507	·10	36·17	1·16	0	2·34	2·26	*	,,
	2	100·2	1549	2·40	32·06	·99	0	2·28	2·48	*	Fish.
	3	99·4	1337	2·47	35·43	1·00	·27	2·70	2·30	—	Meat.
Drugs.—* Sod. Bicarb.	4	99·6	680	1·39	18·02	·59	·14	1·70	1·13	—	,,
	5	99·4	1194	3·20	32·24	·79	2·84	2·83	1·92	—	,,

	Date.	Temp.	H_2O.	Cl.	+ U.	− U.	Acid.	P_2O_5.	SO_3.	Drugs.	Diet.
No. 3.—C. O. C., ♂, 15. Scarlet fever. Admitted March 1st, Discharged March 30th, 1897.	1	103·2°	600	·12	31·62	·57	1·86	1·47	2·07	—	Milk.
	2	103·8	610	·18	31·96	·63	1·89	1·52	1·96	—	,,
	3	102·6	669	·10	36·12	·68	2·14	1·73	2·14	—	,,
	4	101·2	968	·29	39·11	1·04	2·13	1·51	2·34	*	,,
	5	100·2	1630	·10	35·32	1·08	2·44	1·86	2·02	*	,,
	6	102·0	1697	·10	30·55	1·05	3·39	2·49	2·12	*	,,
	7	100·0	1547	·10	27·54	·66	3·09	2·35	1·95	—	,,
	8	100·6	1807	·10	29·27	1·12	4·16	3·70	2·11	*	,,
	9	99·6	1295	·10	22·14	·85	2·46	2·62	1·55	*	Fish.
	10	100·2	982	·88	16·99	·43	1·47	1·94	1·18	—	,,
Drugs.—* Spt. Ammon. Arom. and Sod. Salicyl.	11	99·4	1280	3·20	19·30	·51	1·54	2·12	1·23	—	,,
	12	99·2	970	1·50	18·62	·40	1·94	1·86	·97	—	Meat.
No. 4.—W. L., ♂, 24. Scarlet fever. Admitted March 24th, Discharged May 24th, 1897.	24	104·8°	—	—	—	—	—	—	—	—	—
	25	103·4	757	·53	37·09	·78	2·64	1·56	2·66	—	Milk.
	26	102·2	695	·59	35·58	·78	2·57	2·02	2·42	—	,,
	27	99·8	704	·42	39·96	·81	2·43	1·97	2·68	—	,,
	28	99·2	809	·97	33·77	1·15	2·63	2·43	2·14	—	Fish.
	29	99·4	1000	3·07	37·00	1·37	3·75	3·63	3·06	—	,,
	30	100·4	1005	5·54	31·57	1·20	2·96	2·69	2·21	—	Meat.
	31	99·0	1023	5·01	33·35	1·33	4·09	3·05	2·05	*	,,
Drugs.—* Sod. Salicyl.	1	98·8	1242	4·34	37·26	1·40	4·16	4·00	2·93	*	,,
	2	98·2	1000	4·40	31·70	·94	3·70	2·84	2·14	—	,,

	Date.	Temp.	H_2O.	Cl.	N.	$\frac{+}{U}$.	$\frac{-}{U}$.	NH_3.	Acid.	P_2O_5.	SO_3.	Drugs.	Diet.
No. 5.—A. N., ♂, 20.	9	103·2°	1000	1·60	—	38·20	·97	—	1·85	1·12	2·40	—	Milk.
Scarlet fever.	10	102·8	825	·84	—	37·78	·55	—	1·36	·73	2·01	—	,,
Admitted April 9th,	11	103·0	534	·35	—	25·10	·44	—	1·04	·46	1·47	—	,,
Discharged May 20th, 1897.	12	101·0	739	·22	—	25·21	·49	—	1·18	1·08	1·59	—	,,
	13	99·8	959	·19	—	37·34	·74	—	2·05	1·30	3·53	—	,,
	14	100·2	1115	·67	—	32·00	·67	—	1·67	1·90	2·50	—	Fish.
	15	100·0	1530	4·82	—	27·69	·76	—	·99	1·47	2·39	*	,,
	16	99·4	1949	4·09	—	32·35	1·11	—	1·36	2·85	2·73	*	,,
	17	99·2	1897	3·45	—	31·87	1·04	—	1·54	2·85	2·50	*	,,
	18	98·2	1667	3·03	—	28·84	·85	—	1·53	2·80	3·12	—	,,
Drugs.—* Sod. Bicarb.	19	98·6	856	1·80	—	17·38	·51	—	1·49	1·73	1·47	—	Meat.
	20	98·8	1870	5·74	—	35·16	·80	—	3·03	2·66	2·66	—	,,
No. 6.—W. R., ♂, 17.	11	104·2°	1030	1·45	18·82	33·67	·81	·67	2·49	3·76	2·45	—	Milk.
Scarlet fever.	12	103·0	860	1·05	18·88	35·40	·77	1·04	3·69	3·25	3·00	—	,,
Admitted Jan. 10th,	13	102·0	1002	1·23	18·99	36·08	·67	1·10	2·70	2·59	2·91	*	,,
Discharged March 4th, 1899.	14	98·2	1350	1·72	13·50	25·23	·58	·63	1·20	2·08	2·03	*	,,
	15	99·6	1344	1·42	16·01	29·97	·81	·84	2·10	2·11	2·61	†	,,
	16	98·2	—	—	—	—	—	—	—	—	—	—	,,
Drugs.—* Sod. Salicyl. and Sod.	17	98·0	1295	1·96	12·07	22·58	·63	·41	2·19	2·66	1·80	—	,,
Chlor. † Sod. Salicyl.	18	98·6	750	·90	9·55	18·11	·60	·32	1·46	2·24	1·67	—	Fish.
‡ Mag. Sulph.	19	98·6	1150	2·87	14·25	27·84	·59	·47	2·37	2·54	2·53	—	,,
	20	98·0	1610	4·06	17·60	33·48	·71	·59	3·40	3·17	3·61	‡	,,

	Date.	Temp.	H_2O.	Na_2O.	Cl.	+ U.	− U.	NH_3.	Acid.	P_2O_5. Ac.	P_2O_5. Tot.	P_2O_5. Neut.	SO_3.	K_2O.	Drugs.	Diet.
No. 7.—P. K., ♂, 17. Scarlet fever. Admitted Aug. 3rd, Discharged Sept. 16th, 1899.	6	* 99·0°	682	Trace	Trace	—	—	1·21	—	—	·43	—	—	1·52	—	Milk.
	7	99·2	960	2·12	1·67	—	—	1·44	—	—	1·83	—	—	1·17	—	„
* Temp. on admission 105°.	8	99·6	1498	7·15	6·87	—	—	1·52	—	—	3·06	—	—	2·54	—	Fish.
No. 8.—J. C., ♂, 22. Scarlet fever. Admitted Aug. 28th, Discharged Oct. 7th, 1899.	30	102·6°	1250	·16	·21	—	—	—	—	—	—	—	—	1·06	*	Milk.
	31	100·4	1465	1·13	·34	—	—	—	—	—	—	—	—	·75	*	„
	1	99·0	1194	2·88	·74	—	—	—	—	—	—	—	—	·84	—	„
	2	98·6	974	1·62	1·39	—	—	—	—	—	—	—	—	2·08	—	„
	3	98·4	960	1·39	1·96	—	—	—	—	—	—	—	—	3·66	—	Fish.
Drugs.—* Digitalis.	4	98·4	1079	1·41	2·65	—	—	—	—	—	—	—	—	4·36	—	Meat.
No. 9.—C. D., ♂, 27. Scarlet fever. Admitted Oct. 24th, Discharged Dec. 6th, 1900.	24	104·2°	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	27	101·4	1770	1·78	1·66	57·00	1·09	1·87	1·40	Trace	·67	·67	4·03	1·50	—	Milk.
	28	101·2	1248	1·91	1·16	30·75	·72	·91	·97	·06	·91	·85	2·06	·65	*	„
	29	100·6	2408	4·46	2·66	51·00	1·49	1·00	1·12	·61	2·65	2·04	3·71	1·82	†	„
	30	101·4	1815	3·60	2·17	35·70	1·11	·71	3·33	1·34	3·05	1·71	2·44	2·85	†	„
	31	99·4	1940	2·90	2·10	48·40	1·44	·85	5·00	2·68	4·92	2·24	3·46	5·85	‡	„
	1	100·6	1472	2·05	1·61	38·40	·86	·80	4·57	1·73	3·39	1·66	2·92	4·34	—	„
	2	100·0	1525	3·31	3·20	42·40	1·06	·85	3·28	1·96	4·54	2·58	2·97	5·03	—	„
Drugs.—* Sod. Chlor. 6 grams.	3	99·4	1237	3·16	4·05	34·87	1·04	·85	2·62	1·18	3·18	2·00	2·40	4·37	—	Meat.
† Sod. Chlor. 6 grams and Sod. Salicyl. 3 grams.	4	99·6	1237	3·16	4·05	34·87	1·04	·85	2·62	1·18	3·18	2·00	2·40	4·37	—	„
	5	99·4	867	2·55	2·76	26·20	·76	·63	2·05	1·41	2·76	1·35	1·83	2·05	—	„
‡ Sod. Salicyl. 6 grams.	6	99·2	867	2·55	2·76	26·20	·76	·63	2·05	1·41	2·76	1·35	1·83	2·05	—	„

	Date.	Temp.	H_2O.	Na_2O.	Cl.	$\frac{+}{U}$.	$\frac{-}{U}$.	NH_3.	Acid.	P_2O_5.	SO_3.	K_2O.	Drugs.	Diet.
No. 10.—H. J. B., ♂, 20.	8	102·2°	480	·01	·07	20·90	·38	·68	1·70	1·38	1·98	1·83	—	Milk.
Scarlet fever.	9	100·2	1470	·30	·13	46·40	1·16	1·95	4·12	4·58	3·80	3·39	—	,,
Admitted Dec. 7th, 1900,	10	99·8	1258	·54	·45	31·05	·63	·82	3·22	2·82	2·45	2·14	—	,,
Discharged Jan. 17th, 1901.	11	99·0	1416	2·54	1·45	29·70	·79	·40	2·62	2·88	2·15	1·89	—	,,
	12	99·0	2005	6·11	5·34	44·28	1·18	·86	4·10	4·53	3·64	3·88	—	Fish.
	13	100·6	735	2·39	2·81	25·90	·48	·64	2·75	2·39	2·06	2·43	-	Meat.
	14	97·2	735	2·39	2·81	25·90	·48	·64	2·75	2·39	2·06	2·43	...	--
No. 11.—H. G. B., ♂, 21.	4	104·4°	1160	·24	·19	32·25	·66	—	8·85	3·90	3·80	5·65	*	Milk.
Scarlet fever.	5	101·8	960	·38	·04	45·00	·81	—	4·05	3·30	3·26	2·48	*	,,
Admitted May 3rd,	6	100·2	949	Trace	Trace	48·30	1·00	—	1·87	1·41	2·78	1·60	*	,,
Discharged June 15th, 1901.	7	101·0	1223	·22	·11	66·60	1·42	—	1·42	·75	3·70	1·29	*	,,
	8	100·2	1112	·21	·34	50·40	1·39	—	2·25	2·53	2·72	2·63	*	,,
	9	99·2	1486	·72	·71	37·80	1·44	-	2·48	3·76	2·31	3·88	*	,,
	10	99·8	1710	2·60	1·97	39·55	1·43	-	2·19	4·48	2·39	5·26	*	,,
	11	99·2	1085	1·70	2·07	36·34	1·08	-	2·67	3·89	2·47	4·07	*	Fish.
	12	98·0	1085	1·70	2·07	36·34	1·08	---	2·67	3·89	2·47	4·07	*	,,
Drugs.—* Digitalis.														
No. 12.—V. R. G., ♂, 15.	26	104·4	908	·20	·88	11·80	—	—	—	1·24	1·26	·99	*	Milk.
Relapse of scarlet fever.	27	103·0	1405	·20	1·00	22·50	...	.....	—	·73	2·02	1·38	*	,,
Admitted September 28th,	28	100·0	—	—	—	—	—	—	—	—	—	—	*	,,
Discharged Dec. 5th, 1901.	29	99·2	1328	·31	·29	13·90	—	—	—	·25	1·02	·40	*	,,
Drugs.—* Nux vom. and Digitalis.														

	Date.	Temp.	H_2O.	Na_2O.	Cl.	+ U.	− U.	NH_3.	Acid.	P_2O_5. Ac.	P_2O_5. Tot.	P_2O_5. Neut.	SO_3.	K_2O.	Drugs.	Diet.
No. 13.—H. C. M., ♂, 19.	4	104·4°	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scarlet fever.	5	103·4	1052	·14	·11	31·70	1·13	—	—	—	2·60	—	2·73	3·14	*	Milk.
Admitted Nov. 4th,	6	101·8	1460	·16	·14	60·70	1·50	—	—	—	3·39	—	3·51	3·65	*	,,
Discharged Dec. 17th, 1901.	7	100·8	1636	·12	·16	58·97	1·57	—	—	—	2·78	—	4·63	3·47	†	,,
	8	100·2	1780	·17	·11	85·50	1·89	—	—	—	2·65	—	5·19	4·38	—	,,
* *Drugs.*—Caffeinæ Cit. 1·7 g.,	9	98·0	1720	1·15	·10	81·40	1·78	—	—	—	2·73	—	4·80	5·40	—	,,
Ac. Citric. 3·4 g., Sod. Bicarb.		100·8														
5 g. † Half dose of each.	12	98·2	1955	4·03	1·92	52·80	1·50	—	—	—	3·76	—	3·92	3·27	—	Fish.
No. 14.—C. B., ♂, 18.	2	105·0°	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scarlet fever.	3	103·8	1160	·81	1·04	37·80	—	1·11	3·60	1·25	2·83	1·58	3·25	3·91	—	Milk.
Admitted Jan. 2nd,	4†	103·4	887	·35	·25	40·79	—	1·20	2·80	·70	2·04	1·34	2·98	2·08	*	,,
Discharged Feb. 13th, 1902.	5†	101·0	757	·50	·27	30·32	—	1·00	1·80	·52	1·68	1·16	2·46	1·41	*	,,
	6†	102·4	623	1·12	·18	23·10	—	·50	·85	·17	1·22	1·05	1·73	1·06	*	,,
Drugs.—* Sod. Citratis 6 g.	7	101·8	1685	3·30	·97	59·38	—	·98	1·70	·62	2·85	2·23	3·84	2·36	—	,,
† Fæces of 4th = Na_2O ·02,	8	101·0	2050	3·03	2·82	39·91	—	·91	3·02	1·74	4·15	2·41	3·32	3·29	—	,,
K_2O ·43; of 5th and 6th	9	101·2	2125	3·50	3·84	28·08	—	·65	2·65	1·64	3·26	1·63	2·69	4·39	—	,,
together = Na_2O, traces,	10	100·0	2105	2·19	2·79	33·76	—	1·00	3·66	2·12	3·05	·93	2·88	3·54	—	Fish.
K_2O ·30.	11	99·8	2105	2·19	2·79	33·76	—	1·00	3·66	2·12	3·05	·93	2·88	3·54	—	,,
No. 15.—J. O. S., ♂, 17. Scarlet	22	102·0°	—	—	—	—	—	—	—	—	—	—	—	—	—	—
fever. Admitted Sept. 22nd,	23	100·2	620	·35	·13	29·68	—	—	—	—	1·25	—	2·30	1·82	—	Milk.
Discharged Nov. 6th, 1902.	24	98·8	938	2·40	·69	21·65	—	—	—	—	1·93	—	2·27	5·39	*	,,
	25	98·0	1230	2·86	1·68	30·78	—	—	—	—	2·68	—	3·81	3·89	—	,,
Drugs.—* Pot. Citratis 8 g.																

	Date.	Temp.	H_2O.	Na_2O.	Cl.	N.	+ U.	− U.	NH_3.	Acid.	P_2O_5. Ac.	P_2O_5. Tot.	P_2O_5. Neut	SO_3.	K_2O.	Drugs.	Diet.
							—	—	—	—	—	—	—	—	—		
No. 16. V. B. H., ♂, 16.	6	102·8°				—	—	—	—	—	—	—	—	—	—	—	—
Scarlet fever.	7	102·2	2052	1·08	2·14	—	31·65	·81	1·27	1·34	·32	1·95	1·63	2·37	3·36	*	Milk.
Admitted Oct. 6th,	8	102·2	2400	2·76	2·21	..	29·86	·85	·73	·35	·12	1·59	1·47	2·20	4·64	*	,,
Discharged Nov. 15th,	9	102·2	2500	1·53	1·59	..	31·69	·85	·75	1·46	·57	2·25	1·68	1·84	3·67	*	,,
1902.	10	101·0	3060	2·13	1·94	..	23·76	1·05	·68	2·09	1·13	2·81	1·68	2·34	4·52	—	,,
	11	101·4	3000	1·77	1·67	..	37·18	·97	·70	2·92	1·58	3·64	2·06	2·59	4·81	—	,,
Drugs. * Pot. Citratis 4 g.	12	99·2	2797	2·37	1·99	—	40·74	1·05	·69	2·37	1·56	3·78	2·22	2·70	5·03	—	Fish.
No. 17. F. H., ♂, 22.	14	104·6°	3000	·49	1·38	—	42·18	—	·87	—	—	3·51	—	4·22	5·32	—	Milk.*
Scarlet fever.	15	101·8	1786	·78	1·20	-	36·20	—	1·06	—	—	2·61	—	2·97	3·13	—	,,
Admitted Nov. 14th,	16	101·2	2035	4·03	3·96	—	41·68	—	·92	—	—	3·57	—	2·34	2·86	—	,,
Discharged Jan. 13th.																	
* Milk 2 pints extra, *i. e.* 5 pints.																	
						CaO.											
No. 18. W. H., ♂, 19.	21	103·8°	—	—		—	—	—	—	—	—	—	—	—	—	—	—
Scarlet fever.	22	103·0	655	·08	·37	·05	33·08	·65	·93	2·30	·57	1·76	1·19	2·53	2·54	—	Milk.
Admitted Nov. 21st,	23	101·8	922	·63	·55	·11	50·42	·98	·87	·68	0	1·28	1·28	3·54	4·78	*	,,
Discharged Jan. 15th, 1903.	24	100·4	774	2·04	·29	·07	39·41	·77	·33	·20	0	·86	·86	2·62	3·17	†	,,
Drugs. —* Pot. Citratis 12 g.,	25	98·6	1110	2·07	·81	·11	33·47	·70	·51	·58	·25	1·96	1·71	2·17	1·75	—	,,
Sod. Citratis 12 g.	26	97·2	880	1·67	1·10	·09	31·55	1·00	·68	·50	·95	3·30	2·35	2·45	3·15	—	,,
Drugs.—† Pot. Citratis 6 g.	27	97·8	940	2·40	2·16	·09	31·48	1·08	·67	2·02	1·75	3·51	1·76	2·18	2·83	—	Fish.
Sod. Citratis 6 g.																	

	Date.	Temp.	H_2O.	Cl.	+ U.	− U.	Acid.	P_2O_5.	SO_3.	Drugs.	Diet.
No. 19.—H. W., ♂, 17. Morbilli. Admitted March 25th, Discharged April 7th, 1898.	26	103·0°	800	·29	32·14	·73	3·06	2·72	2·87	—	Milk.
	27	101·4	1182	·10	32·03	·79	3·02	3·19	3·26	—	,,
	28	98·8	420	·10	19·18	·52	1·52	1·67	1·60	—	,,
	29	98·0	562	3·36	35·43	·99	2·56	2·91	2·83	—	Fish.
	30	97·6	650	3·42	22·89	·61	1·92	1·88	1·94	—	Meat.
	31	97·0	680	3·06	26·31	·63	2·04	2·00	1·99	—	,,
No. 20.—W. E. G., ♂, 21. Morbilli. Admitted March 28th, Discharged April 12th, 1898.	28	105·6°	—	—	—	—	—	—	—	—	—
	29	102·6	912	·63	37·82	·67	2·84	2·67	2·35	—	Milk.
	30	101·6	1218	·10	38·72	·90	3·30	3·49	3·58	—	,,
	31	100·0	887	·17	22·02	·58	1·24	1·29	1·96	—	,,
	1	98·6	880	·10	28·57	·98	2·36	2·14	3·45	—	Fish.
	2	98·6	439	·10	17·52	·61	1·26	1·34	2·24	—	,,
	3	99·6	693	·87	25·53	·86	2·06	2·20	2·10	—	,,
	4	98·0	563	·61	18·90	·60	1·60	1·91	1·46	—	,,
No. 21.—P. C., ♂, 27. Morbilli. Admitted May 19th, Discharged June 2nd, 1898.	19	102·4°	—	—	—	—	—	—	—	—	—
	20	99·8	625	·32	22·13	·42	2·02	1·76	1·72	—	Milk.
	21	98·4	545	·10	22·95	·43	1·20	1·06	1·72	—	,,
	22	98·6	830	·16	20·14	·42	·62	1·76	1·74	—	,,
	23	97·4	700	·44	25·82	·68	3·74	3·28	2·37	—	,,
	24	97·0	760	2·06	28·75	·89	2·50	3·78	3·20	—	Fish.
	25	97·0	680	3·20	21·67	·66	2·72	3·04	2·65	—	,,

	Date.	Temp.	H_2O.	Cl.	+ U.	− U.	Acid.	P_2O_5.	SO_3.	Drugs.	Diet.
No. 22.—G. A., ♂, 23. Morbilli.	20	103·8°	—	—	—	—	—	—	—	—	—
Admitted May 20th, Discharged June 2nd.	21	100·0	740	·52	32·85	·60	4·22	3·16	2·69	—	Milk.
	22	97·2	485	·10	13·95	·26	2·08	1·70	1·25	—	,,
	23	97·2	360	·10	14·77	·28	1·94	2·04	1·25	—	,,
	24	97·2	491	·56	20·76	·42	1·72	2·06	2·01	—	Fish.
	25	97·0	586	2·90	20·21	·53	1·52	1·80	1·61	—	Meat.
No. 23.—A. W. M., ♂, 20. Morbilli.	2	104·8°	—	—	—	—	—	—	—	—	—
Admitted June 2nd, Discharged June 16th.	3	103·0	1022	3·39	33·96	·79	2·20	2·20	3·50	—	Milk.
	4	99·2	—	—	—	—	—	—	—	—	,,
	5	98·0	1000	·60	49·13	1·10	4·30	5·02	5·64	—	Fish.
	6	97·4	581	·10	30·17	·71	2·80	3·60	3·18	—	,,
	7	97·4	490	·24	25·92	·65	1·90	2·64	2·01	—	Meat.
No. 24.—W. F., ♂, 23. Morbilli.	13	103·8°	—	—	—	—	—	—	—	—	—
Admitted June 13th, Discharged June 30th.	14	101·6°	1202	1·15	36·00	·81	2·70	2·75	2·94	—	Milk.
	15	97·6	915	1·18	27·61	·61	1·32	2·24	2·03	—	,,
	16	97·0	815	2·16	24·39	·61	1·08	2·04	1·89	—	,,
	17	97·0	870	5·54	26·13	·65	1·42	2·15	2·43	—	Fish.
18th—23rd, pulmonary complications.	18	99·6	889	6·34	27·79	·57	2·54	2·28	2·34	—	Meat.
	19	101·8	695	3·18	27·74	·63	2·82	2·52	2·16	—	,,
	20	101·4	851	3·54	34·26	·79	3·20	2·84	2·69	—	,,
	21	101·4	750	1·90	33·64	·77	3·08	2·68	2·72	—	,,
	22	100·0	830	2·83	33·40	·68	3·08	2·94	2·67	—	,,
	23	99·4	889	3·15	32·45	·75	2·90	2·88	2·52	—	,,
	24	98·4	780	2·32	27·68	·54	2·64	2·50	2·26	—	,,

	Date.	Temp.	H_2O.	Na_2O.	Cl.	N.	+ U.	− U.	NH_3.	Acid.	P_2O_5. Ac.	P_2O_5. Tot.	P_2O_5. Neut.	SO_3.	K_1O.	CaO.	MgO.	Drugs.	Diet.
No. 25.—F. J., ♂ 24. Morbilli. Admitted March 1st, Discharged March 18th, 1899.	3	104·8°	550	·28	·36	12·29	22·95	·50	1·01	1·30	·51	1·72	1·21	1·91	1·66	·15	Trace	—	Milk.
	4	103·0	1688	·27	·96	22·18	42·56	·96	1·67	1·88	·52	2·45	1·93	2·96	2·58	·34	·04	—	,,
	5	99·4	832	·17	·35	12 80	24·02	·61	1·01	1·95	·88	2·61	1·73	1·99	2·03	·13	·03	—	,,
	6	98·2	1160	2·31	·12	18·71	37·29	·88	·89	1·62	·54	3·34	2·80	3·27	2·49	·24	·21	—	,,
	7	97·4	620	1·13	·26	9·79	19·29	·63	·57	·46	—	1·38	—	1·69	1 28	·11	·11	—	Fish.
	8	98·4	930	2·41	2·23	13·60	26·36	·90	·66	1·02	—	2·52	—	2·13	2·79	·27	·04	—	Meat.
No. 26.—W. R., ♂ 26. Morbilli. Admitted March 12th, Discharged April 3rd, 1900.	13	103·4°	848	·17	·27	27·60	—	·78	1 54	3·28	1·04	2·92	1·88	3·19	2·35	—	—	—	Milk.
	14	99·4	256	·05	·07	6·80	—	·30	·45	·78	·29	·81	·52	·85	1·19	—	—	—	,,
	15	98·2	845	·90	Trace	23·22	—	1·22	1·54	3·48	·85	3·42	2·57	3·47	1·53	—	—	—	Fish.
	16	98·0	670	1·06	1·55	17·68	—	1·06	·87	1·96	·74	2·44	1·67	2·09	1·95	—	—	—	,,
	17	99·0	670	1·06	1·55	17·68	—	1·06	·87	1·96	·74	2·44	1·67	2·09	1·95	—	—	—	,,
	18	97·0	945	1·23	4·30	16·48	—	1·23	·81	1·56	·43	2·63	2·20	2·27	3·12	—	—	*	,,
	19	98·6	945	1·23	4·30	16·48	—	1·23	·81	1·56	·43	2·63	2·20	2·27	3·12	—	—	*	,,
* *Drugs.*—Sod. Salicylatis 5 g.																			
No. 27.—M. I., ♂ 20. Morbilli. Admitted May 3rd, Died May 19th, 1901.	4	105·6°	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	5	103·6	660	·40	·16	—	25·22	·78	—	3·19	—	3·01	—	1·84	2·14	—	—	—	Milk.
	6	101·2	665	1·31	·12	—	27·50	·97	—	2·00	—	2·12	—	1·88	1·18	—	—	—	,,
	7	100·8	412	·95	·07	—	18·50	·64	—	·55	—	·66	—	1·14	·53	—	—	—	,,
	8	101·6	428	·56	·10	—	20·20	·67	—	·85	—	·62	—	1·30	·70	—	—	*	,,
	9	101·8	326	·41	·38	—	14·40	·57	—	1·12	—	·88	—	·99	·96	—	—	*	,,
	10	102·0	326	·41	·38	—	14·40	·57	—	1·12	—	·88	—	·99	·96	—	—	*	,,
* *Drugs.*—Caffeine Cit. g. 2. † Pot. Iodidi g. 2.	11	103·0	681	·23	1·19	—	19·12	·67	—	1·20	—	1·21	—	1·28	3·23	—	—	†	,,
	12	100·0	681	·23	1·19	—	19·12	·67	—	1·20	—	1·21	—	1·28	3·23	—	—	†	,,

	Date.	Temp.	H_2O.	Na_2O.	Cl.	N.	$\overset{+}{U}$.	$\overset{-}{U}$.	NH_3.	Acid.	P_2O_5.	So_3.	K_2O.	Drugs.	Diet.
No. 28.—T. E., ♂ 18.	17	105·6°	—	—	—	—	—	—	—	—	—	—	—	—	—
Morbilli.	18	103·4	715	·18	·12	—	29·00	·32	2·32	3·25	3·17	2·00	2·00	—	Milk.
Admitted May 17th.	19	98·6	795	·13	·09	—	35·90	·64	2·39	2·80	2·58	2·07	1·08	—	,,
Discharged June 1st,	20	98·0	995	·54	·25	—	38·70	·75	1·93	2·12	1·90	2·18	1·00	—	,,
1901.	21	97·0	950	·72	·42	—	31·20	·76	1·78	2·35	2·02	2·00	1·21	—	Fish.
	22	97·6	1010	2·54	2·09	—	28·90	·84	1·48	2·50	2·32	1·85	1·54	—	,,
No. 29.—R. M., ♂ 30.	1	99·6°	560	—	1·76	—	17·19	·29	—	1·15	·92	1·90	—	—	Fish.
Rubeola.	2	99·0	556	—	2·30	—	19·08	·33	—	1·50	1·05	1·95	—	—	,,
Admitted April 30th.	3	99·8	593	—	2·43	—	21·72	·50	—	2·17	2·02	1·78	—	—	,,
Discharged May 11th, 1897.															
No. 30.—F. P., ♂ 22.	9	104·4°	—	—	—	—	—	—	—	—	—	—	—	—	—
Rubeola.	10	100 0	1019	—	·46	—	39·76	·85	—	4·62	3·97	4·89	—	—	Milk.
Admitted May 8th,	11	98·0	490	—	·10	—	16·86	·39	—	2·30	2·26	1·48	—	—	Fish.
Discharged May 21st,	12	97·0	696	—	·47	—	24·77	·67	—	2·88	3·38	2·04	—	—	Meat.
1898.	13	97·6	768	—	·75	—	29·05	·90	—	3·98	4·20	4·13	—	—	,,
	14	98·0	1140	—	3·55	—	37·29	·95	—	3·57	4·17	3·18	—	—	,,
No. 31.—F. de V., ♂ 18.	14	102·8°	—	—	—	—	—	—	—	—	—	—	—	—	—
Rubeola.	15	99·4	646	—	·87	—	26·76	·46	—	2·20	1·98	2·75	—	—	Milk.
Admitted May 14th,	16	97·6	525	—	·77	—	26·59	·50	—	2·64	2·50	2·56	—	—	,,
Discharged May 26th,	17	97·0	730	—	3·72	—	28·17	·51	—	2·56	2·32	2·55	—	—	Fish.
1898.	18	97·0	590	—	3·10	—	20·59	·47	—	2·00	1·89	2·06	—	—	Meat.
No. 32.—C. R. A., ♂ 20.	24	104·0°	—	—	—	—	—	—	—	—	—	—	—	—	—
Rubeola.	25	100·2	775	—	1·50	14·65	28·76	·57	—	2·57	2·68	2 09	—	—	Fish.
Admitted June 24th,	26	98·0	1196	—	1·86	13·70	26·43	·56	—	2·49	2·82	2·04	—	—	,,
Discharged July 8th,	27	98·4	1170	—	2·51	14·40	28·13	·49	—	2·67	3·36	2·46	—	—	Meat.
1898.	28	98·0	1000	—	3·11	13·30	26·57	·49	—	2·20	2·73	2·07	—	—	,,

	Date.	Temp.	H_2O.	Na_2O.	Cl.	N.	+ U.	− U.	NH_3.	Acid.	P_2O_5. Ac.	P_2O_5. Tot.	P_2O_5. Neut.	SO_3.	K_2O.	Drugs.	Diet.
No. 33.—F. P., ♂ 17. Tonsillitis. Admitted Sept. 29th, Discharged Oct. 11th, 1902.	30	103·8°	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1	103·0	913	2·37	1·76	—	43·10	1·05	·81	2·53	·92	2·89	1·97	3·11	2·78	—	Milk.
	2	100·4	1160	1·28	·70	—	49·51	·88	·87	3·21	1·61	3·90	2 29	3·21	3·64	—	,,
	3	100·0	1170	·80	·88	—	40·45	·68	·88	2·44	2·12	3·31	1·21	2·75	3·24	—	,,
	4	98·0	1261	1·18	1·00	—	40·63	·70	·70	3·88	1·42	3·61	2·19	2·95	4·05	—	,,
	5	97·2	1292	2·12	2·23	—	36·24	·70	·63	2·62	1·52	3·36	1·84	2·60	3·91	—	,,
	6	97·4	1327	3·37	4·11	—	41·10	·67	·65	3·37	1·75	3·31	1·56	2·98	4·28	—	Fish.
	7	97·8	1327	3·37	4·11	—	41·10	·67	·65	3·37	1·75	3·31	1·56	2·98	4·28	—	,,
No. 34.—A. H., ♂ 19. Diphtheria. Admitted March 28th, Died March 31st, 1897.	28	100·4°	900	—	Trace*	—	38·88	·70	—	3·69	—	3·24	—	4·15	—	—	Milk.
	29	101·4	860	—	Trace	—	40·76	·76	—	2·97	—	2·79	—	3·44	—	—	,,
	30	102·0	905	—	·54	—	36·20	·67	—	2·71	—	2·46	—	2·71	—	—	,,
	31	101·6	800	—	1·20	—	22·24	·46	—	1·64	—	1·56	—	2·08	—	—	,,
No. 35.—T. L., ♂ 28. Diphtheria. Admitted June 16th, Discharged 1898.	17	99·8°	782	—	1·40	18·97	38·10	·82	—	3·42	—	3·00	—	3·33	—	—	Milk.
	18	99·4	934	—	1·72	18·25	36·60	·73	—	3·00	—	3·60	—	2·93	—	—	,,
	19	98·6	1072	—	1·38	12·75	24·63	·57	—	1·29	—	2·87	—	1·94	—	—	Fish.
	20	97·8	890	—	1·92	13·60	27·35	·58	—	1·66	—	2·74	—	2·17	—	—	,,
	21	98·6	1040	—	3·84	16·94	30·40	·76	—	2·57	—	2·95	—	2·66	—	—	Meat.
	22	97·2	1021	—	3·66	13·99	24·61	·61	—	2 66	—	2·70	—	1·93	—	—	,,

* Mere opalescence with $AgNO_3$ and HNO_3.

	Date.	Temp.	H_2O.	Na_2O.	Cl.	N.	$\frac{+}{U}$.	$\frac{-}{U}$.	NH_3.	Acid.	P_2O_5. Ac.	P_2O_5. Tot.	P_2O_5. Neut	SO_3.	K_2O.	Drugs.	Diet.
No. 36.—J. P., 37.	6	100·4°	810	—	1·38	15·77	28·59	·79	·74	3·36	1·08	2·80	1·72	2·57	—	—	Milk.
Diphtheria.	7	98·4	1310	—	·73	16·75	31·59	·57	1·00	6·24	2·37	4·42	2·05	2·71	—	—	,,
Admitted May 5th,	8	98·2	1455	—	1·80	15·26	28·99	·54	·54	4·44	2·98	4·71	1·73	2·54	—	—	,,
Discharged June 8th,	9	98·2	1465	—	1·14	14·66	29·61	·45	·49	3·66	2·64	4·65	2·01	2·20	—	—	,,
1899.	10	98·6	1505	—	·96	14·12	28·11	·37	·24	2·69	1·67	4·10	2·43	2·35	—	—	,,
	11	98·0	1422	—	·78	17·41	32·94	·49	·37	2·88	1·72	4·30	2·58	2·58	—	—	Fish.
	12	98·0	1329	—	·69	20·44	40·61	·69	·20	2·70	1·30	4·48	3·18	2·99	—	—	,,
	13	97·0	1062	—	·60	17·02	34·87	·59	·31	4·71	1·16	3·48	2·32	2·48	—	—	,,
	14	97·2	1228	—	1·44	17·02	33·29	·65	·31	4·99	1·34	3·57	2·23	2·70	—	—	Meat.
	15	97·6	1304	—	1·89	11·62	32·51	·46	·37	3·03	·77	2·18	1·41	1·90	—	—	,,
No. 37.—H. E. M., ♂, 14.	22	104·0°	675	—	·10	—	15·39	·25	—	1·20	—	1·32	—	1·95	—	—	Milk.
Acute nephritis.	23	101·6	550	—	·28	—	14·49	·21	—	1·26	—	1·00	—	1·22	—	—	,,
Onset May 19th,	24	101·0	864	—	·44	—	16·63	·25	—	·28	—	·74	—	1·26	—	—	,,
Discharged June, 1898.	25	98·0	1666	—	1·40	—	19·58	·31	—	2·12	—	1·26	—	1·27	—	—	,,
	26	100·8	1335	—	2·85	—	12·73	·47	—	1·53	—	·93	—	2·01	—	*	,,
	27	103·6	1772	—	2·88	—	24·56	·54	—	1·88	—	1·66	—	2·80	—	*	,,
	28	97·6	1404	—	2·61	—	17·39	·46	—	2·34	—	1·77	—	2·38	—	—	,,
	29	98·8	1752	—	2·56	—	16·85	·52	—	1·52	—	1·52	—	2·22	—	*	,,
	30	99·0	1259	—	3·18	—	17·21	·51	—	1·53	—	1·44	—	2·89	—	*	,,
	31	100·0	1535	—	2·72	—	16·74	·28	—	1·72	—	1·58	—	2·82	—	—	,,
	1	99·0	1465	—	4·14	—	20·26	·36	—	1·50	—	1·33	—	3·26	—	—	,,
	2	100·2	1455	—	1·74	—	19·00	·42	—	2·10	—	2·13	—	3·49	—	*	Fish.
	3	N.	1270	—	2·34	—	22·60	·49	—	1·86	—	1·57	—	4·51	—	—	,,
	4	N.	930	—	1·38	—	22·06	·56	—	2·00	—	1·76	—	2·62	—	—	,,
	5	N.	807	—	·60	—	15·40	·39	—	1·36	—	1·18	—	2·22	—	—	,,
Drugs.—* Mag. Sulph.	6	N.	762	—	1·86	—	19·05	·62	—	1·68	—	1·34	—	2·71	—	*	Meat.
	7	N.	750	—	1·48	—	10·49	·41	—	1·38	—	1·06	—	3·56	—	—	,,
No. 38.—C. D., ♂, 6.	14	98·4°	525	·47	·41	3·75	6·14	·17	·37	·39	—	·57	—	·41	1·02	—	Milk.
Acute nephritis.	15	98·4	458	—	·19	2·41	4·40	·11	·08	·20	—	·50	—	·20	—	—	—
Onset Dec. 13th,	16	99·0	1292	·84	·65	5·42	9·45	·23	·20	·26	—	1·19	—	·54	1·03	—	—
Discharged Jan. 24th, 1901.																	

DISCUSSION.

Captain STATHAM asked what method had been used for estimating urea. There was a considerable margin of error in the simple hypobromide process, and in metabolism experiments it was important that this source of error should be eliminated. In febrile urine he had found the percentage of nitrogen much below that of the ordinary average and in convalescence it was increased. In cases in which the ammonia was high the organic acidity was low. Chlorine was invariably low during the course of the fever. The ratios of the various urinary constituents as given in the paper were very valuable.

Dr. E. I. SPRIGGS said that Dr. Beddard and he in observations on metabolism in diabetes had met with similar problems to those described in the paper. In a case of acute rheumatism, observed by Dr. Beddard, it was noticed that the acidity was raised, but fell at once on the fever subsiding, the urine becoming alkaline. If the brunt of the oxidation processes could be thrown on the nitrogenous tissues it would be of interest. In a healthy man it was found that when put on a diabetic diet the acid became excessive, but when the diet was changed the urine became alkaline. It was probable that the individual had formed an alkaline habit to neutralise the acid as much as possible, which persisted. The fever patients described in the paper appeared to be practically living on proteid, and in them variations in acidity might be due to diet rather than to any specific effect of the fever. Ammonia did not seem to share the fluctuations of the acidity of the urine, and in the case of rheumatic fever referred to the ammonia excretion remained constant. The amount, however, varied with the diet. If a patient were given alkali, the ammonia excretion might be reduced to a very low point, but not abolished. It was suggested that the meaning of the presence of ammonia might not be due to a reversion to type, but to the fact that every tissue formed ammonia as a last change before urea; ammonia must therefore circulate in the blood, and hence in the blood that passed through the kidney without having passed through the liver; such ammonia would be excreted by the kidney as ammonia. This was a similar explanation to that given for the appearance of purin bodies in the urine. The increase of ammonia in fever was greater than in proportion to the nitrogen, but it was possible that the liver cells were poisoned and less able to change ammonia salts into urea. The evidence accumulated was not sufficient to allow it to be said that ammonia was not excreted to neutralise acids, but only that all the ammonia of the urine was not there from

this cause. In a case of migraine the phosphoric acid excretion did not accurately follow that of uric acid. In migraine the phosphoric acid excretion was considerably disturbed, much more than the nitrogen. The uric acid excretion followed the water closely.

Dr. R. HUTCHISON referred to the chloride excretion in fever; in pneumonia there was a great decrease, and he had thought the chlorides were retained in the fixed tissues, but after Dr. Garratt's observations he recanted this opinion. One of the chief results of the paper was to shake confidence in Salkowski's work; it might be that sodium was retained for its own sake as part of the protective mechanism of the body. It was surprising that the phosphoric acid bore so much less relation to uric acid than one would have expected if they were both derived from the breaking-up of nucleins; it made the uric acid question still more puzzling. It seemed as if it were a hopeless task to study metabolism from the end results obtained by an analysis of the excreta.

Dr. GARRATT, in reply, said that exhaustive methods for the analysis of nitrogen were not possible for the same investigator simultaneously with exhaustive analysis of alkalies and other bodies. The urine might be acid, although acid phosphates were entirely absent. Post-febrile alkalinity was said to be very frequent after pneumonia by Pick, who attributed it to the return of sodium. Under ordinary conditions ammonia probably played no part in neutralising acids; in grave conditions of acid poisoning, where the fixed bases proved insufficient, it might do so, but not in fever. Much of the paper was a protest against the simple explanation given of these complex processes.

THE CARDIAC DULNESS IN CASES OF CANCER

BY

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I WOULD venture, in as few words as possible, to draw your attention to a physical sign which has, I think, hitherto escaped notice, yet one which, if my observations prove correct, should be found valuable in a considerable number of cases.

Some years ago, in the routine examination of several patients with gastric cancer, I observed that, although no evidence existed of ordinary emphysema, the area of cardiac dulness, mapped out in the recumbent position, was either much reduced or actually obliterated. In some of them, where the dulness was obliterated, the resonant note over the heart was, it is true, slightly higher pitched than over the lung, but it was definitely resonant, not dull. The reduction or obliteration of the cardiac dulness was sometimes associated with a rather surprisingly small and soft pulse.

Since my first observations I have often noticed this curious physical sign and, some time ago, I became so sure that it suggested cancer that I risked the diagnosis of cancer on the strength of it where otherwise the

evidence was inconclusive, and in five consecutive cases the diagnosis proved correct.

The reduction or obliteration of the dulness was observed, as I have said, in the recumbent position. It is necessary to insist on this point, because our text-books

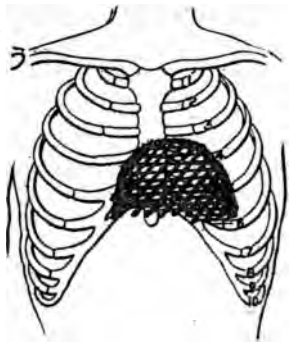

FIG. 1.—Normal cardiac dulness in upright position.

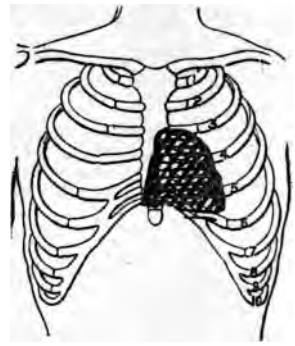

FIG. 2.—Normal cardiac dulness in recumbent position.

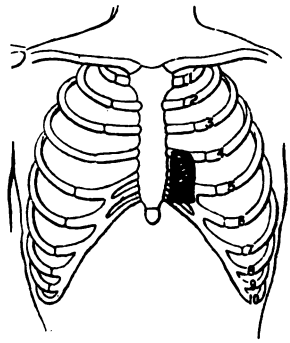

FIG. 3.—Cardiac dulness in a case of cancer where it has not been yet obliterated.

do not clearly recognise the differences in the physical signs of the heart which exist in the recumbent and upright positions. As the result of many observations on healthy and diseased hearts, I have found that the heart dulness alters considerably with change of position. Diagrams 1 and 2 illustrate the change in the cardiac dulness which

usually occurs when a healthy adult changes his position from the upright to the recumbent. Diagram 3 illustrates the reduction in the recumbent dulness in a case of cancer where it has not been altogether obliterated.

The following cases illustrate the general usefulness of this physical sign, being instances in which a diagnosis of cancer was arrived at partly by means of it.

CASE 1. *Pain; vomiting; moderate loss of weight; no tumour; loss of cardiac dulness; operation; gastric cancer.*—A man aged 42, a labourer, complained of epigastric pain relieved by food. This had come on six months previously, but disappeared under treatment. It reappeared two and a half months before his admission to hospital, accompanied by flatulence and headache. Three weeks before his admission he began to be sick, but more after fatigue than after food. Once only he noticed a very little blood after much retching. He was not at all wasted in appearance, but said he had lost flesh. There was almost no cardiac dulness, although there was no indication of ordinary emphysema. His chest was of normal shape, and expanded well on inspiration. There had been no winter cough, and there had been no breathlessness. Examination of the stomach contents after a test meal showed absence of free hydrochloric acid and presence of lactic acid. No tumour could be felt. I advised laparotomy, hoping that early operation might reveal a cancer which could be removed. My colleague Mr. Harris found a cancer of the anterior wall of the stomach, but considered that its extent and attachments rendered extirpation impossible.

CASE 2. *Profuse hæmatemesis; loss of cardiac dulness; rapid wasting and development of a tumour.*—An elderly woman, after some weeks of indefinite gastric symptoms, was seized with a profuse hæmatemesis. She was stout, and her appearance gave no suggestion of malignant disease. There was no evidence of emphysema, but her cardiac dulness was absent. The bleeding having been

arrested, feeding by the mouth was resumed as quickly as possible, but she wasted exceedingly rapidly; and Dr. Pollock, with whom I had seen her, tells me that before death a well-marked tumour could easily be made out in the region of the stomach. An autopsy could not be obtained.

CASE 3. *Wasting; tumour; loss of cardiac dulness; death; autopsy; gastric cancer.*—A woman of about 45 was seen by me with Mr. Miller. She had been losing flesh, and a tumour had developed to the left of the umbilicus and a little below it. She had obviously no emphysema, but her cardiac dulness had disappeared. I decided the tumour was a pyloric cancer, and this diagnosis was found correct by Mr. Miller, who performed an autopsy.

CASE 4. *Dysphagia; absence of cardiac dulness; subsequent paralysis of right vocal cord; death; autopsy; cancer of œsophagus.*—A professional man of about 45 was seen by me with Mr. Dyball. He was then complaining of difficulty of swallowing, which had been coming on gradually. He was a well-nourished but highly nervous man. As aneurysm seemed exceedingly improbable in his case, I passed a No. 21 bulbous œsophageal bougie. This was gripped once or twice but, the grip relaxing before gentle steady pressure, the bougie passed fairly easily into the stomach. It appeared uncertain whether the case was one of cancer or spasm. He had no emphysema, the chest expanding well, but the heart dulness had entirely disappeared. The pulse, too, for a man of his appearance, was surprisingly small and soft. I suspected cancer, but deferred a definite opinion until I had seen him again. A couple of weeks later Mr. Miller, who was looking after him in Mr. Dyball's absence, asked me to see him. His voice had become hoarse. I found paralysis of the right vocal cord. The diagnosis of cancer was then definitely made. On the patient's death Mr. Miller made a careful post-mortem examination, and found two broad cancerous

areas in the œsophagus. The heart was of normal size, but the lungs completely overlapped it.

CASE 5. *Dysphagia; loss of cardiac dulness; death; autopsy; cancer of œsophagus.*—A man of 35 came to hospital complaining of difficulty of swallowing. There was no emphysema, but the cardiac area of dulness was reduced to one inch in breadth at the level of the fourth costal cartilage. The pulse was extremely small and soft. Cancer of the œsophagus opening into the trachea was discovered post mortem.

CASE 6. *Intestinal obstruction; loss of cardiac dulness; operation; cancer of descending colon.*—An elderly woman was seen by me for the first time on the operating table. She had intestinal obstruction, and there was a question as to whether this was caused by a cancer of the descending colon. Owing to the abdominal distension it was impossible to arrive at any conclusion by palpation. There was absolute loss of cardiac dulness, and I ventured to predict that a cancer would be found. In the course of the colotomy an extensive cancer was discovered in the colon above the sigmoid flexure.

These six cases illustrate sufficiently the usefulness of this physical sign as an aid to diagnosis in certain cancerous cases. My experience with regard to it lies chiefly amongst cases in which some part of the alimentary canal is involved. Whether it is equally frequent in cases of cancer of other parts, such as the breast, I am unable to say. I have seen it in breast cases, but I have also found it wanting in these when I should have expected it to be present.

Its diagnostic value in cases where it occurs depends, of course, on its absence in other conditions. I have looked for it carefully in a very large number of non-cancerous cases, with or without wasting, and with or without a resemblance to cancer as regards symptoms. So far as my experience goes, it is very uncommon to find the heart

dulness lost, or markedly reduced in area, in non-cancerous cases where emphysema can be excluded; but it is not invariably absent in non-cancerous cases, any more than it is invariably present in cancerous cases. All one can claim for it is that, when present in a doubtful case, it is highly suggestive of the presence of cancer and, when absent, at a late point in the case, its absence is somewhat suggestive of the absence of cancer.

With regard to the period of its appearance in a cancerous case, one may say that it may precede cachexia, pronounced wasting, or the loss of skin elasticity which is often obvious, especially in the abdominal skin, in abdominal cancer cases. Unhappily it does not seem to be usually so early a symptom as to make a practical difference in the date of attempts at extirpation of the disease. Although it has perhaps enabled me, more than once, to suggest an exploratory operation earlier than I should otherwise have done, I have as yet only met with one case in which *absence of cardiac dulness* has helped on a successful removal of the growth.

In assessing the value of absence of heart dulness in any given case, one would, of course, take into account not merely emphysema, but any cause capable of withdrawing the heart from contact with the chest wall, such as the retraction of adhesions in the back of the pleural cavity. Conversely, in assessing the value of a normal heart dulness where cancer is suspected, one would naturally consider causes which might prevent the dulness being decreased, such as enlargement of the heart from any cause, pericardial effusion, retraction of diseased lungs, adhesions to the front of the chest, or pressure from behind pushing the heart forwards.

The following three cases illustrate the presence of a normal heart dulness in non-cancerous cases where cancer has been suspected.

CASE 7.—*Chronic jaundice; wasting; pain; cardiac dulness normal; operation; no cancer; recovery.*—Mrs. T—,

aged 49, had had pronounced jaundice for nine months, occasional severe pain in the right hypochondrium, especially after food, occasional vomiting, and considerable loss of weight. In twelve months she had come down from 11 st. 8 lbs. to 9 st. 12 lbs. The liver was uniformly enlarged. There was no ascites. The motions were persistently clay-coloured. The appetite varied. Under medicinal treatment the pain and sickness lessened, the jaundice slightly decreased, and she gained weight slowly.

Three months later I was sent for to see her by her medical attendant, Mr. Goulden. She had had a very severe attack of pain and vomiting. She had become thin again. The heart dulness was rather larger than normal, although cardiac and renal disease were absent. I advised operation with a view to the removal of a possible gall-stone in the common bile-duct. The possibility of cancer was discussed, and I decided against it. Mr. Russell Coombe operated and found no cancer. No gall-stone was discovered, but as a result of the manipulation of the bile-duct some obstruction was evidently removed, as the patient has made a complete recovery, her jaundice having disappeared.

CASE 8. *Jaundice; wasting; normal heart dulness; recovery.*—An elderly woman, very thin, sallow, almost cachectic looking, with pronounced jaundice and a history of loss of weight, was seen by me with Mr. Miller. Her history was most difficult to elicit, and the duration of the jaundice was doubtful. The liver was enlarged and tender. The cardiac dulness was of ordinary size, although no cardiac or renal disease existed. The case strongly suggested cancer, so strongly that I did not feel justified in deciding definitely against it, but on the strength of the broad heart dulness I gave more hope of recovery than I could otherwise have done. Under treatment the jaundice disappeared, the patient gained flesh, and recovery now appears to be complete.

CASE 9. *Abdominal tumour; cardiac dulness normal;*

operation; "caseous kidney."—This patient, a man in middle life, was seen by me after the exploratory operation. The broad cardiac dulness would have, I think, decided me against carcinoma.

It would no doubt be rather rash to lay great stress on the absence of reduction of the cardiac dulness, but, as a matter of experience, its absence seems to me to have, as in these three cases, a certain value of its own.

The following case, however, shows that a normal cardiac dulness may persist even to the end of a case of gastric cancer, though its persistence in such a case is, I think, very uncommon. Usually, when the heart dulness is normal in the early stages, it becomes greatly reduced or obliterated towards the end. The absence of reduction of the cardiac dulness in this case is particularly interesting, as the growth was exceptionally circumscribed and chronic in character.

Case 10. *Pyloric obstruction; great wasting; normal cardiac dulness; death; autopsy; small hard cancer.*—A man aged 46 had been vomiting profusely on and off for about nine months. Six months before I saw him a diagnosis of non-malignant pyloric obstruction had been made in America and he had been taught to wash out his stomach daily. In view of an old history of severe pain near the pylorus, it was possible the obstruction might be due to the cicatrisation of an ulcer. He was extremely thin, but I could discover no tumour. The cardiac dulness was normal. I advised such treatment as seemed necessary to stop sickness and promote gain in weight, and directed that as soon as his condition was somewhat improved operation should be undertaken, either gastro-enterostomy or, if a cancer existed and seemed removable, pylorectomy. His sickness ceased, and in five weeks he put on nearly a stone in weight. Unfortunately the latter half of my advice was not carried out, and he came under my care again when his old symptoms had returned and when his condition made operation impossible. At the autopsy the

pylorus was found stenosed and indurated, but not enlarged in its outside dimensions. A slowly growing, very circumscribed cancer spread from it a short way into the gastric wall. Only one or two neighbouring glands seemed affected. The growth evidently was one of slight general and local malignancy, the patient having died chiefly from its mechanical effects.

The following case was one in which the cardiac dulness, normal when first examined, slowly decreased in size under observation.

CASE 11. *Pain; wasting; cancer of stomach at œsophageal orifice; gastrostomy; cardiac dulness slowly decreased.* —The patient came under my care in hospital. My colleague, Mr. Roper, performed gastrostomy and found a large cancer growing into the stomach at the œsophageal orifice. The heart dulness was then normal. During the patient's quiet life in hospital after the operation I noticed that the area became slowly but steadily smaller.

In non-cancerous cases I have seen the cardiac dulness markedly reduced in three instances only. I do not think I have ever seen it lost.

One case was a woman with a large uterine fibroma. She was seen two years ago and is now well. The second was a case of chronic diarrhœa which I had only a short time under observation, and believe to have been tubercular. The third was a man with chronic gastritis, who is much better at present, eighteen months having elapsed since I saw him.

The cause of this curious physical sign has, of course, been a matter of interest to me. At first I fancied that the reduced area of dulness might be accounted for by the reduced size of the heart, because the heart is supposed to waste disproportionately quickly in cancerous patients. But a few post-mortems made this theory untenable. The heart was not strikingly small,—one heart was rather over the average in size, I should say,—but in each case the lungs met, or nearly met, over it. The

encroachment of resonance on the heart dulness was thus easily explained. But it is less easy to explain this forward movement of the lung edges. Perhaps that may be best accounted for by supposing that, just as in many cases of cancer, of abdominal organs especially, the skin of the abdomen becomes strikingly inelastic, so a similar loss of elasticity may occur in the lung structure, whereby even ordinary breathing can cause a sort of false emphysema, in consequence of which the edges of the lungs gradually close over the front of the heart. If this be the true explanation, it will account for the fact that in the earliest stages of cancer the sign is not present, and for the further fact that in sarcoma, which does not affect skin elasticity as cancer does, I have so far failed to find it.

In conclusion, I would sum up thus the result of my observations:

Putting aside cases where special causes exist, either for the obliteration of the heart dulness or for prevention of such obliteration, the following seem to be true:

1. Great reduction or obliteration of the normal cardiac dulness is common in cases of cancer, particularly in cancers of the alimentary canal and in their late stages.

2. This loss of cardiac dulness does not seem to be found in the earliest stages of a cancerous case, but may precede cachexia, marked wasting, and loss of skin elasticity.

3. It is rarely observed in non-cancerous cases.

4. It is rarely absent in the later stages of cases of cancer of the alimentary canal.

5. It does not seem to occur in cases of sarcoma.

6. In doubtful cases its presence is highly suggestive of cancer; its absence is slightly suggestive of the absence of cancer, if the symptoms under consideration have lasted for several months.

I should like to express my indebtedness to my friend Mr. Miller for the great help he has given me in watching cases to their conclusion, and for the careful autopsies he has made to confirm our diagnoses.

DISCUSSION.

The PRESIDENT remarked that the paper had interest from both the medical and the surgical side. Dr. Gordon had been careful to exclude the diminution in the cardiac dulness that might be due to ordinary emphysema of the lung, to retraction of the heart, or to atrophy of the heart. It was to be understood, he gathered, that the decrease in the cardiac dulness in cancer cases was to be ascribed to a kind of presenile or atrophous emphysema, and he would ask if any microscopical examination of the lung had been made and if any such atrophous change had been found. Experience as to the condition of the cardiac dulness in cancer cases obtained from cancer hospitals, and from other places, where a large series could be investigated, would be of interest.

Dr. HERBERT FRENCH asked if importance were ascribed to the presence of the sign at a first examination of the patient, or if it must develop under observation.

Dr. GORDON, in reply, said he had not himself examined the lung microscopically, but in one of the cases a microscopic examination had been made by Mr. Miller, and it was negative. He looked upon the condition as due to a loss of elasticity, which might not give rise to any obvious microscopic appearance. Even quiet breathing, he thought, might cause overlapping of the heart by the lung if there was merely diminution of elasticity. The absence of the cardiac dulness was the point on which he laid stress as of value in diagnosis. Its gradual disappearance under conditions incapable of causing ordinary emphysema, in a case of cancer, supported his view that in some way the cancer caused the loss of dulness.

PEPTIC ULCER OF THE JEJUNUM

BY

A. W. MAYO ROBSON, F.R.C.S.

Received November 25th, 1903—Read April 12th, 1904

THE subject of peptic ulcer is an extremely interesting one, that has given rise to much speculation and to many theories.

In the stomach it is extremely common, in the duodenum probably much more frequent than hitherto supposed, but in the jejunum it is generally acknowledged to be very rarely found; in fact, it is only four years since Braun first described the formation of peptic ulcer in the jejunum of man, and although the subject has received some attention in Germany—Braun, Hahn, Kausch, Korte, Kocher, and others having described cases—this is, I believe, the first case described in English literature.

In a paper describing a peptic jejunal ulcer following on gastro-enterostomy in a dog, Dr. S. H. Watts has collected and tabulated fourteen cases; I have heard of another which has not yet been published, and my own would make the sixteenth case; but as all of these cases were perforating ulcers it almost goes without saying that there must be many more that have existed unrecognised, and probably many others that may have caused death by abscess and in many other ways, in which the

adhesions and other complications have so obscured the parts that even an autopsy has failed to elucidate the true nature of the disease.

The true cause of peptic ulcer, whether gastric, duodenal, or jejunal, is probably a mild form of sepsis leading to gastritis and excess of free HCl in the gastric juice, though traumatism, either by coarse food or through external injury and interference with the circulation in the bowel, has been assigned as a cause, but without what seem to me adequate reasons.

Peptic ulcer is distinctly one of the sequelæ to be reckoned with after gastro-enterostomy, though it seems much more likely to occur after the anterior than the posterior operation.

It is curious that so far as we know it does not occur after pyloroplasty, but whether the operation of Finney, which makes a much more extensive opening, will be followed by peptic duodenal ulcer, time alone will prove.

As regards the frequency of peptic jejunal ulcers, out of 136 posterior gastro-enterostomies which I have personally performed I have not had one example, nor has one occurred among 100 posterior gastro-enterostomies operated on by a colleague.

My case occurred after an anterior gastro-enterostomy, one out of 30 that I have performed; and Kausch reported 2 out of 160 gastro-enterostomies performed in Professor Mikulicz's clinic, both being after anterior gastro-enterostomies.

Of the cases in the table, the anterior operation had been done in 11, the posterior in 2, and the Y operation of Roux in 1; but whereas in the 2 cases of peptic ulcer occurring after the posterior operation perforation was followed by general peritonitis, in the 11 anterior operations the peritonitis was limited in 8 and diffuse only in 3.

The symptoms in my case were evidently chiefly referable to the perigastritis and the extensive adhesions, and although there was intense and agonising pain at times, it seemed to bear no relation to food.

Vomiting did not occur, nor was the loss of flesh very marked, but hæmorrhage was a distinct feature, and the presence of a well-marked tumour at the site of perforation is to be noted.

Treatment.

Though well recognised, I think it has not been sufficiently grasped that the essential cause of peptic ulcers is of a septic nature, and in many cases the source of trouble is oral; hence probably the greater frequency of gastric ulcer among the poorer classes; the sequence of events being septic gastritis, hyperchlorhydria, and ulceration.

In the cases of gastric ulcer that have failed to yield to medical treatment, and in which gastro-enterostomy has been performed, I fear that we have not properly grasped the fact that the operation is, though an important one, still only an incident in the treatment, which ought to be continued on general lines for some time longer, or until good health is again established. Greater attention to oral asepsis and to the gastric condition of hyperchlorhydria subsequent to operation is advisable, and in this way the very serious complication of peptic ulcer in the jejunum and relapses in gastric ulcer might be prevented.

In all the cases reported, perforation, associated with acute, subacute, or chronic symptoms, has occurred, as will be seen by referring to the tabulated list; hence there can be no question as to the desirability—nay, as to the absolute necessity of operation, which ought not to be delayed too long. When the abdomen is opened the treatment will depend on the condition found.

If perforation has occurred into the general peritoneal cavity the condition will be one of the utmost peril, and only capable of relief by immediate cleansing of the peritoneum and closure of the opening, or by excision of the ulcer with subsequent suture.

Though peptic ulcer of the jejunum is less frequent after posterior gastro-enterostomy, only two cases having

been recorded, when it does occur it is more likely to be acute and not to lead to adhesions.

If, as in the greater number of cases, adhesions have formed, the condition will be less acute, although very distressing from the associated pain due to perigastritis and adhesions. It will be necessary to detach adhesions and to repair the perforation, but probably in the greater number of cases an excision of the portion of intestine involved and the performance of a Roux's operation will give the best results.

Case of peptic ulcer, occurring in jejunum three years and four months after gastro-enterostomy, treated by enterectomy and Roux's operation; recovery.—Mr. C—, aged 44, was sent to me by Dr. Peter MacGregor, of Huddersfield, on January 2nd, 1900, with the history that he had had pain after food, together with other symptoms of gastric ulcer, for four years, though his first attack of vomiting blood occurred in May of the previous year. The bleeding was rather profuse, but under medical treatment and rest he recovered, and was able to resume his occupation. A week before he was sent there had been a recurrence of the hæmorrhage, which was repeated three days later.

On his arrival at the surgical home he was in a state of collapse with a barely perceptible pulse. There was well-marked dilatation of the stomach, with tenderness over the pylorus. The history of the pain occurring one and a half hours after food, together with the site of the tenderness and the presence of a large amount of blood in the motions, left no doubt but that the ulcer was at or near the pylorus. As the bleeding had recurred twice in the week, and was persisting and passing into the bowel, operation was decided on. This was done on January 4th, 1900. As the patient was in such a feeble condition, every precaution was taken to guard against shock, and it was decided only to perform gastro-enterostomy, as it was quite clear that he would not stand any prolonged search

for the bleeding point. An anterior gastro-enterostomy was done, a decalcified bone bobbin being used to make the anastomosis, the opening being made close to the lower border of the stomach. The pylorus and first portion of the duodenum were very much thickened, evidently the result of ulceration. His temperature and pulse were never above normal, and he made an uninterrupted recovery. He was fed by nutrient enemata for the first few days, only taking sips of water by the mouth; but at the end of that time he was allowed to take milk and soda water, and then gradually to have stronger food. He was up at the end of the third week, and returned home within the month.

The patient remained well for two years, had neither pain after food nor vomiting. He gained his normal weight and was able to do his work. After this he began to have pain at the epigastrium. The pain seemed to bear no relation to food, and was unaccompanied by vomiting. There was marked tenderness at the epigastrium, especially on the left of the middle line. At times the pain was so acute as to cause him to roll on the floor and to perspire profusely. At first the attacks were not very frequent, only coming on at intervals of a month or two, but recently they had been more frequent, almost daily, and during the week before I saw him dark blood had been noticed in the motions on several occasions.

He was sent to me by Dr. James Hall on May 5th, 1903, when a well-marked tumour was found occupying the epigastrium, and decidedly tender to pressure; but there was no vomiting, and no sign of stomach dilatation could be discovered. Tarry matter was seen in the motions.

The diagnosis of thickening around a chronic ulcer and perigastritis was made, and an exploratory operation advised. The abdomen was opened by an incision just to the right of the middle line, and the stomach was found adherent to the anterior abdominal wall, one inch to the left of the old scar. On separating the adhesions it was found that ulceration had occurred at the point of junction

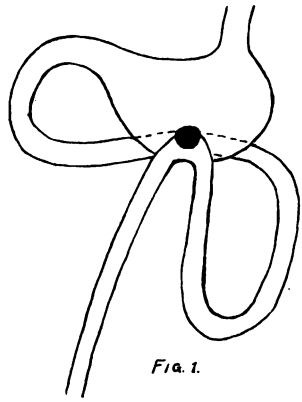

FIG. 1.

FIG. 2.

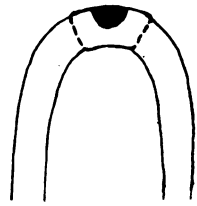

FIG. 3.

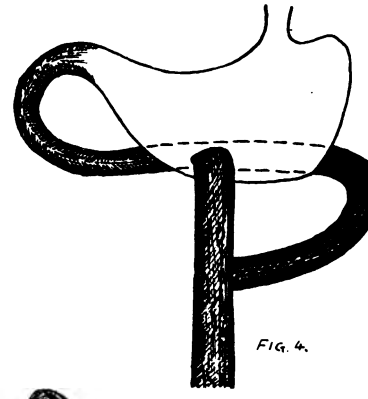

FIG. 4.

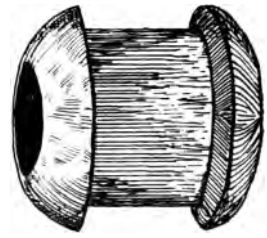

FIG. 5.

1. Diagram of condition found on separating adhesions, May, 1903, showing perforation. 2. Diagram of portion of ulcer adherent to and detached from anterior abdominal wall. 3. Diagram of portion of intestine excised. 4. Diagram of anastomosis performed after the enterectomy. 5. Size of bobbins used.

between the bowel and the stomach, and that it had involved the whole circumference of the jejunum at that point, the ulceration having completely extended through the intestinal wall at the front; but this must have occurred after adhesions, so that there had been no acute symptoms of perforation. Through the opening left when the adhesions had been separated the finger was passed into the stomach, when it was found that the pylorus had quite closed as a result of the ulceration three years before, so that nothing could have passed through it. On passing the finger into the intestine, extensive ulceration and thickening were discovered. The ulcerated portion of the bowel was completely excised and then separated from the opening in the stomach, the edges of which were pared; the distal end of the jejunal loop was implanted into the old opening in the stomach, the union being effected over a bone bobbin, the proximal end was implanted into the jejunum about four inches lower. This union was also effected over a bone bobbin.

The accompanying drawings show the site of the perforation, the base of the ulcer taken from the anterior abdominal wall, the portion of intestine excised, and the intestinal anastomosis that was adopted.

The patient made a steady recovery, so that on June 2nd the following note was made: "The patient is now quite well and is entirely free from his old pain. The wound has completely healed by first intention." He returned home on June 2nd.

When seen by his medical man at home on June 4th, he was smoking a cigar and expressed himself as very well. Soon afterwards he had a little pain in the region of the gall-bladder, and on June 9th he had a free hæmorrhage, as shown by melæna, after which he made a good recovery and remained well. A report from Dr. Hall in November, 1903, says that he is in good health.

Analysis of Reported Cases.

Operator.	Operation anterior or posterior.	Gastric acidity.	Operation for	Number of cases.	Number of ulcers.	Time after operation.	Result.
Braun	Posterior	Normal	Dilated stomach	1	1	1 year	Perforation; peritonitis; death.
Hahn	All anterior	All cases +	Benign stenosis of pylorus	3	—	—	First case, perforation and death. Second and third cases, abscess; operation; cure.
Kausch	All anterior	2 cases +; 1 case normal	First and second cases, pyloric stenosis; third case, ulcer of stomach	3	First and second cases, 1 each; third case, ulcer recurred	First case, 4 months; second and third cases, ?	First and second cases, perforation; abscess; operation; cure. Third case, recurrence of ulcer; jejunostomy; death.
Körte	Anterior	+	Gastric ulcer	1	1	3 years	Perforation; peritonitis; death.
Steinthal	Posterior	+	Pyloric stenosis	1	4	10 days	Perforation; death.
Neumann	Anterior	+	Functional pyloric stenosis	1	1	3—4 months	Perforation; abscess; operation; cure.
Kocher	Y of Roux	—	Gastric ulcer	1	1	12 months	Perforation; abscess; operation; cure.
Heidenhain	Anterior	Normal	Pyloric stenosis with ulcer	1	1	3—4 months	Perforation; adhesions; operation; cure.
Goepel	Anterior	Both +	Pyloric stenosis; gastric dilatation	2	1 each	First case, months; second case, 13 months	First case, perforation; death. Second case, perforation; suture; cure.
Mayo Robson (May 5th, 1903)	Anterior	+	Hæmatemesis due to gastric ulcer	1	?	3 years and 4 months	Perforation; adhesions; enterectomy; Roux's operation; cure.
Quenn (June, 1901)	Anterior	+	Stenosis of pylorus	1	?	4 years	Ulceration; adhesions; enterectomy; Roux's operation; cure.

The subject of peptic ulcer is one of great interest that may be further elucidated by experimental work and by accurate clinical and pathological investigation; and my excuse for bringing forward only one case must be that the disease is fortunately uncommon, this being, I believe, the first that has been reported in this country.

DISCUSSION.

Mr. F. C. WALLIS asked why peptic ulcers of the jejunum should be so common in anterior jejunostomies, and not in posterior. It was to be assumed that the reason was a mechanical one.

Mr. D. J. ARMOUR asked whether the closure of the pylorus was due to the ulceration, or to the loss of function after gastro-enterostomy.

Mr. H. J. PATERSON asked whether it was not possible that the ulcer might be secondary to adhesions which had formed between the jejunum and the anterior abdominal wall? In support of this view he quoted a case where three weeks after the performance of gastro-jejunostomy he opened the abdomen in order to perform the operation of pylorectomy. He found the transverse colon adherent to the anterior abdominal wall by dense adhesions, on separating which he found an ulcer of the colon, which he thought was secondary to adhesions which had formed between the colon and the lower part of the incision through the abdominal wall.

Mr. ROBSON, in reply, thought that anterior gastro-enterostomy did not so efficiently drain the stomach as did the posterior operation, hence the hyperchlorhydria was not so completely relieved, and this had apparently a causal connection. The adhesions were due to a protective perigastritis, and this would prevent general peritonitis when perforation took place. In this case the perforation had occurred into the anterior abdominal wall after the formation of adhesions. The closure of the pylorus was due to cicatricial contraction following on the extensive pyloric ulceration found at the first operation, and was not dependent on loss of function.

THE MENTAL CONDITION IN EPILEPSY IN RELATION TO PROGNOSIS

BY

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In a previous communication to this Society ('Med-Chir. Trans.' vol. lxxxvi, p. 259), I dealt in general terms with the prognosis and curability of epilepsy, with reference more particularly to the convulsive element. In the present paper a special study has been made of the influence of the mental condition in epilepsy upon the prognosis of the disease.

That the mental condition in epilepsy has been the subject of much investigation is apparent from a review of most of the treatises upon the disease. Morel speaks of the "epileptic character," and other writers refer to the characteristic loss of memory and irritability of temper shown by many epileptics. Reference is also not uncom-

monly made to epileptic insanity; but authorities differ as to the frequency and causation of a disordered mental state. Whether, indeed, it is an essential feature of the disease, whether epileptics tend invariably towards dementia as a natural consequence of the malady, or whether it is dependent upon the frequency, the character, or the severity of the seizures, is the subject which will now be brought under discussion.

A brief reference may first be made to the proportion of epileptics who become mentally afflicted according to the statements of different writers. Esquirol,[1] for instance, stated that of 385 epileptic women observed in the Salpetrière, 73 per cent. were mentally afflicted. Russell Reynolds[2] referred to the fact that of the sixty-two cases studied by himself, 38 per cent. were free from any mental failure, 46 per cent. showed some degree of mental impairment, and 14 per cent. were demented. Wildermuth[3] mentioned that the percentage varied according to whether the cases were observed inside or outside an institution. From the observation of his institutional cases, he found 78 per cent., and of those outside the institution, 47 per cent. mentally afflicted. Habermaas,[4] who has studied the mental condition in detail amongst the patients attending the Epileptic Institute at Stettin, gives the following figures:—17·3 per cent. were intellectually normal, 21 per cent. were able to earn wages, 30 per cent. could do some work, and 49 per cent. were so demented that they were unable to work at all. Of those patients who were inmates of the institution, only 13 per cent. were intellectually normal, and 22 per cent. were demented, while the remainder showed intermediate degrees of mental failure. Some further facts mentioned by Habermaas may be added. He refers to Tigges, who found 23 per cent. out of 124 epileptic children mentally defective, and to

[1] Esquirol, 'Des Maladies Mentales, etc.,' Paris, 1838.

[2] Russell Reynolds, 'Epilepsy,' London, 1861, p. 43.

[3] Wildermuth, quoted by Habermaas.

[4] Habermaas, 'Allg. Zeitsch. f. Psychiatrie,' vol. lviii, p. 243.

Pelman, who found 50·8 per cent. of epileptics mentally healthy.

The above-mentioned facts show that in the opinion of many writers upon epilepsy, mental failure is more common than mental health, and that this is true whether the patients are observed inside or outside an institution for epileptics.

The Mental Condition in Epilepsy.

The mental state in epilepsy is usually described under two heads, first, that which may be regarded as incidental to the seizures, and secondly, the interparoxysmal condition. The former heading includes all those delusional, maniacal, and melancholic states which precede or succeed more especially the major convulsions, and which may be considered as constituting epileptic insanity; while the latter embraces the mental attitude and characteristics of the patient between the seizures, and may with confidence be looked upon as the typical epileptic mental condition. It is therefore the latter element of the disease which will receive detailed consideration in the following pages.

Following upon the lines laid down by Reynolds, Habermaas, and others, sane epileptics have been divided according to their interparoxysmal condition, roughly into four classes, showing slight, profound, or intermediate degrees of mental deficiency, and the general features of those classes may be briefly described as follows:

Class A.—In this division are included all those epileptic individuals in whom no mental impairment can be detected. They may be regarded as differing in no way from normal persons in the same social sphere and with similar educational advantages; the memory is good, they are bright, active, and intelligent, and they are capable of earning their own living; only in rare instances do they show the epileptic face. Their physical condition

is good. For all practical purposes they may be regarded as normal.

Class B.—This class, to which the majority of epileptics belong, includes those who exhibit the first degree of mental enfeeblement, which is characterised mainly by some defect of memory, more especially a forgetfulness of recent events. In other respects their mental condition is good; they have fair intelligence and capacity for work, they are able to earn their living and to attend to their several duties. Their physical condition varies. A considerable proportion show the epileptic face.

In *Class C* are found those cases which present the second degree of mental impairment. In addition to an impaired memory, there is defective power of initiation and capacity for work, which, however, may be well done under direction and supervision. They are slow in comprehension, and are often lazy. Many of them are irritable and passionate. About 50 per cent. show the epileptic face.

Class D contains those who show the third or most pronounced degree of dementia. They present the typical features of epileptic dementia, viz. a very defective memory, confusion of ideas, poor capacity for work even under direction, absence of initiative, and a slow and dull comprehension. Although not legally insane, they require supervision. Their physical condition is as a rule good, they eat heartily and sleep well. The majority have the epileptic face.

Under these heads the mental condition in epilepsy will receive consideration, but a passing reference may be made to certain elements in the mental state which will not be specially considered later on. I refer to the *epileptic temperament.*

Epileptics are usually of a sociable disposition. The majority are possessed by a religious fervour, which, forming a marked feature of their disease, contrasts strongly wth their actions, these being mostly perverted, passionate, or even immoral. On the whole they are self-opinion-

ated, and possess a conceit and assurance which is out of all relation to their achievements. Their mental perspective is in consequence entirely blurred and disproportioned, giving to their views and methods an importance which cannot be legitimately claimed for them. While admitting of striking exceptions, their want of initiative is characteristic. On this account, although some are good workers, most require supervision and direction. Points also to be observed in the epileptic character, no doubt the direct consequences of the malady, are lethargy and laziness, combined with an extreme pugnacity and hastiness, which make them contentious and difficult to live with.

Of the more purely mental characteristics, I would refer in the first place to the temporary dulling of the memory and of the finer mental faculties which is to be observed during a temporary increase in the frequency of the fits, more especially observable at the commencement of the disease. This mental clouding should not be mistaken for the beginning of epileptic dementia; it is a common mental phase of many of the patients at the time of their admission to the epileptic colony, and in the majority of cases it clears up under the judicious administration of bromides, or when the patient is removed from unsatisfactory domestic or other environment.

Of these characteristics, I would mention secondly the fleeting irritability, lethargy, impairment of memory, and even delusional state which not infrequently precedes for a day or two the onset of a fit or fits. This is a condition well worthy of careful recognition, as those who live with epileptics are often able to predict a seizure. This state is, however, prodromal to the attacks, and is not considered as evidence of interparoxysmal mental failure.

The Statistics.

The cases forming the material for this paper are those which have been under care and treatment at the Colony for Epileptics, Chalfont-St.-Peter. Such cases lend them-

selves the more readily for observations upon the mental characteristics of epilepsy, as previous to admission they have probably experienced some form of treatment, and have become in the majority of instances confirmed epileptics.

For various reasons particular care is taken in the selection of the cases admitted to the colony. Mere frequency or severity of the fits does not disqualify patients for admission, but the following are, if at all possible, refused:—(*a*) Those who from physical causes are not sufficiently strong to undertake some kind of active work; (*b*) those who from habitual irritability of temper and awkwardness of disposition would not live in harmony with their fellows, or be amenable to rules and regulations; (*c*) those who are imbecile, demented, delusional, or liable to dangerous impulses. In this way an attempt is made to separate the sane from the insane epileptic. The cases, therefore, which form the subjects of the present observations are as far as possible illustrative of the mental condition characteristic of epilepsy as met with outside asylums for the insane.

There are several obvious advantages in studying epileptics in such an institution as an epileptic colony. There is first the fact that the patients are under constant supervision and treatment; secondly, the mode of life, the diet and the general care and hygiene are uniform, and thirdly, the work is apportioned according to individual capabilities and tastes.

The observations have been conducted over periods varying from six months to ten years. The number of fits is recorded on specially designed charts, whilst the mental condition and the working capabilities of the patients are noted from time to time. Treatment by bromides is reduced to a minimum, only a few patients receiving more than the 30 grains of bromide of potassium prescribed at bedtime.

The total number of cases upon whom observations have been made is 161, of these 102 are males and 59 are

females. They include all ages from fourteen to fifty. Only one patient was admitted over fifty years of age (viz. fifty-eight).

In the study of the cases the statistical method has been adopted, and the results are recorded in percentages. Although, as elsewhere pointed out, objections may be raised against this method, it is deemed to be the best available, and the results show a marked uniformity when considered from various points of view.

Statistical Facts bearing upon the Interparoxysmal Mental Condition.

The several varieties and degrees of the interparoxysmal mental state in epilepsy, the relation to the various stages and types of the disease, and the bearing upon prognosis, will be discussed in detail under the following headings:

1. Sex.
2. Hereditary predisposition to epilepsy and insanity.
3. Duration of the disease from the commencement of the convulsions.
4. The age of the patient at the onset of the disease.
5. The character, type, and combination of the seizures.
6. The frequency of the seizures.
7. The facies epileptica.

1. *Sex.*—In this and the following tables epileptics have been classified according to the degree of mental impairment already described on a previous page into four sub-divisions.

Table I *gives the Total Number of Males and Females, with their Percentage Frequency in the Four Sub-divisions of Mental Failure.*

Mental class.	Males.	Females.	Total.	Total percentage.
A	9 (8·8 per cent.)	13 (22·0 per cent.)	22	13·6
B	35 (34·3 „)	16 (27·2 „)	51	31·6
C	29 (28·4 „)	12 (20·3 „)	41	25·4
D	29 (28·4 „)	18 (30·5 „)	47	29·1
Totals	102	59	161	99·7

From this it appears that the greatest number of epileptics (31·6 per cent.) were found to belong to Class B, and to show only the slightest or first degree of mental impairment. But if, on the other hand, the table be so subdivided that Classes A and B, C and D be bracketed together, it will be found that 45 per cent. belong to the former and show none or only slight mental deficiency, while 54·5 per cent. belong to the latter and show mental deterioration in its most pronounced forms. It is therefore obvious that the cases herein tabulated give a larger proportion which exhibit mental deterioration of a marked type.

It should, however, be pointed out that the above percentages do not faithfully depict the mental state of epileptics in general, as it is obvious that those cases which seek treatment at a colony do so on account of some mental disability which prevents them earning a living under ordinary conditions. Secondly, if the table be read in vertical instead of horizontal columns, it will be seen that a larger percentage of women (22 per cent.) escape the deteriorating influence of epilepsy than men (8·8 per cent.); but that when dementia supervenes and reaches its most pronounced form, a larger percentage of women (30·5 per cent.) are affected than men (28·4 per cent.). The most frequent mental condition in males is seen to be a slight impairment of the memory and a blunting of the higher mental faculties (Class B).

If these figures are compared with those given by Habermaas, a close correspondence will be found to exist between them and the cases observed at the Stettin Institute, as will be apparent from the annexed table.

	Stettin Institute.	Chalfont Colony.
Intellectually normal	13 per cent.	13·6 per cent.
With poor memory	20 „	31·6 „
Feeble-minded	42 „	25·4 „
Demented	22 „	29·1 „
Total cases	226	161

2. *Hereditary disposition.*—The hereditary tendencies

referred to under this heading are epilepsy and insanity. On account of the difficulty in obtaining satisfactory information on these points, a large number of cases have had to be eliminated owing to the absence of any note either establishing or disproving such a family disposition. Of the total of 161 cases there was no note of a heredity to either epilepsy or insanity in seventy-three. The following table shows the result of the investigation among the remaining eighty-eight cases.

TABLE II *shows the Presence or Absence of a Hereditary Disposition in Eighty-eight Cases.*

	A.	B.	C.	D.	Total.
No known heredity	11	18	9	11	49
Epilepsy { Paternal	0	8	2	3 }	29
Epilepsy { Maternal	4	5	5	2 }	
Insanity	1	2	2	5	10
	16	33	18	21	88

The distribution and percentages are therefore the following in the several mental classes:

In A there are 5 cases out of 16 with hereditary tendencies, or 31 per cent.
„ B „ 15 „ 33 „ „ 45 „
„ C „ 9 „ 18 „ „ 50 „
„ D „ 10 „ 21 „ „ 47 „

The facts, therefore, which may be deduced from Table II are that those epileptics who show no mental impairment (Class A), or only some impairment of memory (Class B), present a lower percentage with hereditary neurotic tendencies than those cases which exhibit dementia in its more pronounced forms (Classes C and D). This fact, taken by itself, points to the deteriorating influence which a family disposition to epilepsy or insanity has upon the mental condition of those who subsequently develop epileptic seizures.

The table may profitably be compared with one which was given in a previous paper[1] to illustrate the effects of

[1] 'Med.-Chir. Trans.,' loc. supra cit.

an hereditary history upon the general results of treatment in epilepsy. From this it was seen that of those cases which had a hereditary disposition to epilepsy, 36 per cent. became confirmed epileptics, while of those without such history only 19·2 per cent. became confirmed.

The general deduction, therefore, which may be drawn from the above facts is that a family tendency to either epilepsy or insanity, although offering no obstacle to the arrest of the seizures in favourable cases, materially increases the probability of the disease becoming confirmed and the supervention of dementia.

3. *Duration of the disease.*—The influence of the duration of the disease upon the degree of mental decrepitude has been regarded by many writers as of much significance. In opposition to the commonly expressed opinion upon this matter, Russell Reynolds held to the belief that the duration of epilepsy from the commencement of the seizures was without influence upon the mental condition of the epileptic.

A table has, therefore, been constructed with a view to throw further light upon this part of the subject. A total of 160 cases has been used in the construction of Table III, which gives the duration of the disease in quinquennial periods, with the number and percentage frequency of the cases in the four classes of mental disability. It should be especially borne in mind that the term *duration* here signifies the length of the disease as indicated by the epileptic seizures and not of the mental impairment alone.

TABLE III *shows the Duration of the Disease and the Number and Percentage Frequency of the Cases in the Four Mental Classes.*

Duration.	A.	B.	C.	D.	Total.
Under 5 years	6 (27·2 %)	10 (45·0 %)	3 (13·6 %)	3 (13·6 %)	22
6 to 10 „	13 (30·9)	10 (23·8)	7 (16·6)	12 (28·5)	42
11 „ 15 „	1 (3·1)	10 (31·2)	10 (31·2)	11 (34·3)	32
16 „ 20 „	1 (3·5)	4 (14·2)	10 (35·7)	13 (46·4)	28
21 „ 30 „	1 (4·7)	8 (38·0)	4 (19·0)	8 (38·0)	21
Over 30 „	1 (6·6)	6 (40·0)	7 (46·6)	1 (6·6)	15
Mean duration	3·8 years	8 years	6·8 years	8 years	160

From a consideration of the above table the following general deductions may be made:

1. That under five years' duration there is a considerably greater percentage of cases with no mental impairment, or merely some interference with the memory (Classes A and B, 72 per cent.), than of those with well-marked mental deficiency (Classes C and D, 27 per cent.).

2. That of those cases in which the disease has existed from six to ten years there is a slightly greater percentage in Classes A and B (54·5 per cent.) than in Classes C and D (45 per cent.).

3. But that if the convulsions have lasted for periods over ten or eleven years only a trifling percentage of cases are to be found in Class A, the majority showing the mental characteristics of Classes C and D.

4. It should, however, be especially pointed out that in a very few cases the disease may have lasted for periods of thirty or more years without any obvious mental impairment.

It has been stated by Russell Reynolds that if the mean duration of the disease in the several classes be taken, it will be found that its influence upon the mental condition is trivial. Further reference to Table III will show that the mean duration of the disease in Class A is 3·8 years, while that of Classes B, C, and D varies from 6·8 to 8 years. There is not, therefore, that progressive increase in mean duration in the several mental classes that might be expected, for the difference between the mean duration of Class A, which contains those cases without any obvious mental impairment, and Class D, comprising those with the greatest degree of dementia, is about four a half years, being practically the same as that between A and B, in which latter class we find those with merely some impairment of memory.

It may, therefore, be concluded that although the duration of epilepsy from the commencement of the seizures is a potent factor in determining the subsequent mental con-

dition, it is not the only influence in the production of dementia.

4. *Age at onset.*—There is a total of 157 cases in which the age at onset of the disease was known.

In order to gauge the influence, if any, which this factor has in determining the subsequent mental condition of the patient, a table has been constructed giving the number and percentage frequency of epileptics in the four mental classes, the age at onset being subdivided into quinquennial periods from birth to thirty-five years.

TABLE IV *shows the Age in Quinquennial Periods at Onset of the Fits, with the Number and Percentage Frequency in the Four Mental Classes.*

Age.	A.	B.	C.	D.	Total.
Birth to 5 years	1 (3·3 %)	9 (30·0 %)	9 (30·0 %)	11 (36·6 %)	30
6 „ 10 „	3 (11·5)	8 (30·7)	7 (26·9)	8 (30·7)	26
11 „ 15 „	10 (18·1)	15 (27·2)	17 (30·9)	13 (24·5)	55
16 „ 20 „	7 (24·1)	8 (27·6)	5 (17·2)	9 (31·0)	29
21 „ 25 „	0	4 (57·1)	1 (14·2)	2 (28·5)	7[1]
26 „ 30 „	1 (16·6)	1 (16·6)	1 (16·6)	3 (50·0)	6[1]
31 „ 35 „	0	2 (50·0)	0	2 (50·0)	4[1]
					157

From this table we may deduce the following general conclusions:

1. That a low percentage of the cases forming Class A is to be found amongst those epileptics in whom the disease commences in early childhood; amongst them also is to be found a high percentage of those showing profound mental impairment, and if we exclude those in whom the disease commenced after twenty-one years of age owing to the smallness of the numbers, the lowest percentage of cases with mental integrity and the highest with mental infirmity are to be found amongst those epileptics in whom the disease commences in infancy and early childhood.

[1] The small number of cases shown here is due to the fact that at the Epileptic Colony epileptics are preferably admitted under twenty or twenty-one years of age.

2. From the first quinquennial period onwards to that of sixteen to twenty years of age the percentage of cases showing no obvious mental deficiency progressively increases until in the fourth quinquennium (16 to 20 years) a greater percentage of cases is to be found in the combined Classes A and B (51·7 per cent.) than in the combined Classes C and D (48·2 per cent.).

3. No general deductions may be safely drawn from the cases in the succeeding quinquennial periods owing to the fewness of the cases observed, but it may be said in general terms that, in epilepsy commencing over twenty-one years, about an equal percentage show only impairment of memory (Class B) and the higher degrees of mental deficiency (Classes C and D).

These results are at variance with what was noticed by Russell Reynolds working along similar lines. This observer noted that whether the disease commenced early or late in life, more cases were to be found in Classes A and B than in C and D; in other words, "that the mind is not specially affected in those whose epilepsy begins early, neither is it in those whose disease is late in its development" (p. 166 *op. cit.*).

On the other hand, the results obtained in this present research support the contention of most of the older writers on epilepsy, and confirm what has been pointed out in a previous article upon general prognosis (*loc. cit.*, p. 268), viz., that epilepsy commencing in infancy and childhood is least favourable for arrest of the fits and most favourable for the production of confirmed cases. It is also found that the common type of epilepsy—that commencing during the period of puberty—is most suitable for arrest of the seizures and least likely to be associated with mental infirmity.

5. *Character of the fits.*—The character of the epileptic seizures has for long been regarded as an important factor in determining the mental condition. It is generally accepted that the petit mal variety exerts a greater deteriorating influence upon the mind than the convulsive or

grand mal type. This is no doubt the common experience of those through whose hands numbers of epileptics pass. A table has therefore been constructed to show the effect of the two common types of seizure upon the mental state. A total of 159 cases has been used, in whom the character of the fits was definitely known.

TABLE V *shows the Percentage Frequency of the Four Mental Classes in the Common Types of Epilepsy.*

Type.	A. Per cent.	B. Per cent.	C. Per cent.	D. Per cent.	Total.
Grand mal only	24·3	27·0	27·0	21·6	74
Petit mal only	7·1	42·8	21·4	28·5	14
Combined grand and petit mal	4·2	32·8	25·3	38·9	71
					159

The grand mal type, therefore, when occurring alone, is not found to be characteristically accompanied by profound mental impairment, for the table shows an almost equal percentage of cases in the several mental classes. On the other hand, the greatest frequency and highest degree of dementia is to be found in those cases which are characterised by a combination of the grand and petit mal attacks, only four per cent. of such cases being found without any obvious mental impairment.

The general deductions therefore are :—

(*a*) Mental deterioration is found in association with both types of seizure, but its presence is less frequent in those cases in which the grand mal is the main expression of the disease ; (*b*) freedom from mental impairment is also found in both types, but to a minimal extent in those cases characterised by petit mal whether alone or in conjunction with grand mal ; (*c*) the mind is more frequently affected to a slight extent (Class B) in those cases in which the petit mal seizures occur alone ; (*d*) the mind attains its most universal and profound impairment when the disease is manifested by a combination of grand and petit mal attacks.

In amplification of these statements it may be mentioned

that figures have been brought forward to show (*loc. cit.*, p. 274) that the grand mal seizures are the most readily influenced by treatment, while distinctly less favourable are the cases of combined grand and petit mal.

6. *Frequency of the seizures.*—In order to facilitate the consideration of the influence of the frequency of the epileptic attacks upon the mental condition, the fits have been divided into those which may be conveniently counted by the day, the week, the month, the quarter, and the year. There have been added in a separate column those whose incidence is especially in series, while a further group has been formed of those cases in which the fits have been arrested.

In an institution such as the Colony for Epileptics it is a comparatively easy matter to register the number of the seizures, and at the Chalfont Colony this is done on specially constructed charts, so that at a glance there can be seen the daily, weekly, monthly, etc., incidence of the seizures, whether grand mal or petit mal in character, and whether they occur by day or during sleep.

By fits occurring in series I refer to those specially interesting cases where, in place of one or two fits occurring at a time, series of fits, sometimes amounting to several score, occur over a short period, to be followed by a variable interval of freedom before the succeeding batch ensues.

TABLE VI *shows the Percentage Frequency of the Attacks in the Four Mental Classes.*

Frequency.	A. Per cent.	B. Per cent.	C. Per cent.	D. Per cent.	Total.
Daily (one or more)	0·0	17·4	27·9	55·5	18
Weekly (one or two)	1·3	26·3	33·3	39·0	72
Monthly (one or two)	25·7	48·5	17·1	8·5	35
Quarterly (one or two)	57·1	14·2	28·5	0·0	7
Yearly (one or two)	50·0	50·0	0·0	0·0	8
In series	7·6	23·0	23·0	46·1	13
Arrested cases	50·0	16·6	16·6	16·6	6
					159

At the first glance there will be noticed a definite relation between the frequency of the seizures and the mental

state, to such an extent that when the fits are of very frequent recurrence (daily), none of the patients were without obvious mental impairment, over 50 per cent. of them being in Class D, and therefore exhibiting the highest degree of dementia. On the other hand, if the seizures are so infrequent as to be counted by the quarter or year, over 50 per cent. were found in Class A, while none at all were grouped in Class D. Between these extremes there are various gradations, so that the general statement may be made that there is a direct relationship between the frequency of the seizures and the degree of mental impairment—the more frequent the attacks the more common and profound the associated dementia.

If attention is now directed to those seizures whose recurrence is characterised by batches, it will be observed that in this type we are dealing with cases unfavourable to the maintenance of mental integrity, considerably more than double the number of such patients being found with the severer grades of mental deficiency (69·1 per cent.). In this type of epilepsy, therefore, we are confronted with a variety of the disease prone to the development of dementia.

The mental state of those cases in which the seizures have been arrested, either with or without treatment, presents features of great interest, for the table shows that even when the fits are arrested there is not necessarily an unimpaired mental state remaining; that is to say, that arrest of the seizures does not *ipso facto* imply arrest of the disease. The significance of this will be considered with other points in a later paragraph.

Nothing illustrates more forcibly the severity of the disease than the frequency of the seizures, for in addition to the close association between frequency of seizures and mental deterioration there is a remarkable relation between the frequency and the arrest of the fits. Attacks which recur every three or four months, or once or twice a year, show the highest percentage of arrested and the lowest percentage of confirmed cases; and the converse also holds

good, in that attacks recurring so often as several times a day show no cases of arrest (*op. cit.*, p. 273) just as in Table V they show no cases of mental integrity.

7. *The facies epileptica.*—The close relation which exists between mental disability and facial expression is nowhere more readily seen and studied than in cases of confirmed epilepsy. So characteristic indeed is the facial appearance of many epileptics, that the term *facies epileptica* has been applied to it. Although difficult to define, it is readily discerned by those who are in the habit of treating large numbers of epileptics. It may, in general terms, be described as an expression of dulness and heaviness, with an absence of emotional mobility of the features. It differs from that of the ordinary dement by a particular expression, which stamps the individual as an epileptic.

That the epileptic appearance is largely dependent upon the mental attitude may be seen from the following table, which has been constructed to show the percentage frequency of the facies epileptica in the four mental classes.

TABLE VII *shows the Frequency of the Facies Epileptica in the Mental Classes.*

	A.	B.	C.	D.	Total.
Total cases	22	51	41	47	161
Facies epileptica seen in	2 or 9·0 %	16 or 31·3 %	21 or 51·2 %	34 or 72·3 %	73 or 45·3 %

Of a total, therefore, of 161 cases, seventy-three, or 45·3 per cent., showed the expression of countenance known as the *facies epileptica.* Its presence was noted in those with mental integrity as well as in those showing the several degrees of dementia, but its percentage frequency showed a progressive accession as the degrees of dementia increased, until in Class D as many as 72·3 per cent. of the epileptics showed the characteristic expression. It is more frequently seen in male than in female epileptics, for of the seventy-three cases only nineteen were women.

Is the Interparoxysmal Mental Condition in Epilepsy an Integral Part of the Disease?

It is generally known, and the observation has been amply corroborated by the foregoing statistics, that both mental integrity and mental impairment may be found amongst epileptics; but the question arises whether the mental condition which characterises the interparoxysmal period in many epileptics forms an integral feature of the disease, or is induced by the character, the duration, and the frequency of the seizures, or by any other peculiarity of the malady.

As reference has already been made to the views of the earlier physicians upon this subject and the divergence of opinion which is held upon it, it is only necessary in this place to consider how far the present statistics throw any further light upon the solution of the question.

In the first place, it may be stated *that mental failure is not essential to the idea of epilepsy.* On the one hand, it is seen that a certain number of epileptics present no obvious mental deficiency, notwithstanding an inherited predisposition to the disease, a duration of the malady for from twenty to thirty years, its onset in early life, the combination of both the major and the minor seizures, and a recurrence of the seizures so frequent that they may be counted by the week. On the other hand, it has been shown that pronounced dementia may exist when there is no known heredity, when the disease is of short duration (under five years), when the age at onset is as late as the fourth decennium, whether the attacks are of the grand or petit mal type, and even when the seizures have been completely arrested.

Secondly, an attempt will be made to show, on the basis of the collected cases, that *the mental condition is not a direct consequence of the seizures, but is an expression of the same nervous constitution which gives rise to the convulsions,* but influenced by various coexistent factors, such as hereditary disposition, duration of the disease, age

of the person at the onset of the convulsions, and the character and frequency of the paroxysms.

(*a*) A hereditary disposition to epilepsy and insanity —in other words, a family degenerative neurosis—favours the production of the severer types of dementia and the establishment of the disease as a confirmed malady, as shown in Table II.

(*b*) The duration of the disease is a potent factor in determining the mental condition, but its influence is incidental to, rather than causative of, the mental decrepitude; for, as is shown in Table III, a fair percentage of cases of extreme dementia are met when the disease has lasted less than five years, as well as a percentage of cases with mental integrity after the fits have persisted for over fifty years.

(*c*) Upon the character or type of the seizures depends to a large extent the degree of mental impairment. But dementia and mental integrity are inversely associated with the severity of the attacks, the major convulsions being as commonly accompanied by mental health as by profound dementia. On the other hand, the minor seizures are more frequently found with mental failure than with mental health (Table V). The nature and combination of the attacks therefore provide an indication of the severity of the disease. The petit mal attacks when occurring alone are more frequent than the grand mal under similar conditions, but the combination of the two kinds occasions a frequency and intensity of the seizures, which furnishes an indication of the degree and intensity of the malady. But the character of the seizures, though influential, is not solely responsible for the mental condition, for it is found that both types, separately or in combination, are associated with mental integrity as well as with mental deficiency.

(*d*) The *facies epileptica* is found in those who show the slighter as well as the more profound degrees of dementia, but there is also a very small percentage of epileptics with normal mental attitude in whom this feature is

present. Although its presence is not directly referable either to the degree of mental infirmity, or even to any mental deficiency at all, the proportion of cases in which it is observed is in direct relation to the intensity and severity of the mental decrepitude. Hence the facies epileptica is another feature of the degenerative neurosis producing the disease, of which convulsions and mental impairment are further symptoms. The severity of the disease, therefore, is gauged by the combination of the grand and petit mal attacks, by the degree of dementia, and by the occurrence of the facies epileptica.

(*e*) There is a direct association between the frequency of the seizures and the mental state, for the more frequent the attacks the greater the degree of mental impairment, and *vice versâ*. If the severity of the disease in any given case is gauged partly by the frequency and partly by the character-combination of the paroxysms, then it is found that the severer the disease the greater the tendency towards dementia. For it is a well-recognised clinical fact that attacks which recur daily, or weekly, are rarely either of the major, or minor, types alone, but a combination of the two, with the minor variety the more obtrusive. And in this relation attention may be also directed to that class of epileptic in whom the fits are particularly in series. These cases indicate a modification of the disease, with periodic exacerbations of extraordinary intensity, and in them we find a high percentage of dements. We have also seen that there exist certain cases of epilepsy in whom the fits have been arrested either spontaneously or by treatment. In these all classes of mental impairment may be met, so that arrest of the seizures does not necessarily imply arrest of the disease.

(*f*) The age at which the disease commences, determined by the onset of the seizures, influences to some extent the subsequent mental condition; in other words, the earlier the onset of the fits the less the probability of an unimpaired mental condition and the greater the chance of the establishment of confirmed epilepsy. The type of

cases found in institutions for epileptics shows this more obviously than those which remain outside, no doubt on account of the greater severity of the disease in the former, indicated by the greater frequency of the seizures and by the combination of the major and minor fits.

The evidence adduced in this paper tends to support the view that the earlier the onset of the disease, especially under ten years of age, the greater the probability of mental failure, but that the small percentage of cases admitted to the colony over twenty-five years of age does not permit of any definite statement being made as to what occurs when the disease is late in onset.

Summary and Conclusions.

1. A total of 161 cases, which have been under the writer's observation at the Colony for Epileptics, Chalfont-St.-Peter, has been used for the investigation.

2. The mental features of the interparoxysmal state have been divided for descriptive purposes into four classes, the first containing those epileptics without any obvious mental impairment, and the fourth those with the highest grade of dementia.

3. The interparoxysmal mental condition is discussed in its several varieties and degrees, with special reference to the influence of sex, hereditary disposition, age at onset, and character, duration and frequency of fits.

4. Sex has little influence upon the mental condition; but it may be stated in general terms that males are numerically more afflicted than females (91 per cent. of the former to 78 per cent. of the latter), but that the highest degree of dementia is somewhat more common in women than in men.

5. A family predisposition to epilepsy and insanity, although not necessarily militating against the retention of normal mental faculties, favours the supervention of some degree of mental impairment. A higher percentage with a hereditary history is found amongst those epileptics who

show the profounder degrees of dementia, than amongst those who show merely impairment of memory or a normal mental condition.

6. The duration of the disease influences to some extent the mental condition. Mental impairment is less frequent when the fits have lasted for under five years, just as mental integrity is less commonly seen when attacks have persisted for ten or more years. But mental health and mental deficiency are observed in cases in which the disease has lasted, respectively, for over twenty years and for less than five years.

7. The age at the onset of the convulsions influences to some extent the subsequent mental condition, for the earlier the onset, especially during infancy and childhood, the less the probability of an unimpaired mental state.

8. The character and combination of the fits has an important relation to the mental condition, the profoundest degrees of dementia being most commonly seen when the major and minor attacks co-exist. The petit mal seizures occurring alone are found with the lower grades of mental impairment. When the grand mal occurs alone, mental health is as common as mental deficiency.

9. There is a direct association between the frequency of the fits and the mental state, the more frequent the seizures the greater the degree of mental impairment and *vice versâ*. Fits recurring in series are accompanied by a high grade of dementia.

10. The term *facies epileptica* is applied to the physiognomy characteristic of the disease in many epileptics. It is found more commonly with the higher grades of dementia, but its existence is not limited to such cases, for it is observed in those with only impairment of memory as well as without any mental failure.

11. The view is upheld that the interparoxysmal mental condition seen in most cases of epilepsy is one expression of the neurosis of which the fits constitute another; that the former is therefore not directly dependent upon the seizures, and that the frequency and character-com-

bination of the paroxysms in association with the degree of mental failure, indicate the severity and intensity of the disease.

12. The following figures show the percentage frequency of the four classes of mental deficiency amongst the 161 cases used for the purposes of this paper:

Class A, intellectually normal .	13·6	per cent.
Class B, with impaired memory	31·6	,,
Class C, feeble-minded . .	25·4	,,
Class D, demented . .	29·1	,,

DISCUSSION.

The PRESIDENT asked if the *facies epileptica* could be in any way precisely defined; also whether any post-mortem changes characteristic of epilepsy were recognisable in the brain?

Dr. FLETCHER BEACH thought that the fact that hereditary predisposition had a deteriorating mental influence in epileptics was what would *à priori* have been expected, and it was interesting to find that this was borne out by statistics. The mental changes being more pronounced in epilepsy dating from early life probably depended on the greater nerve instability at that period, and the lack of education. At Chalfont a few years ago children were taken at the age of fourteen, and were educated by a schoolmaster with great improvement in their conditions, but no provision is at present made there for the education of younger children. That *petit mal* was not amenable to treatment probably accounted in part for the greater mental change in it. Probably the proper place for cases of masked epilepsy was an asylum. Of 1000 idiots at Darenth, one-third suffered from epilepsy, and the greater proportion of them lapsed into dementia. After a fit in school, it was noticed that the patient not only forgot what he had learned that morning, but also what he had learned during the previous week.

Dr. C. HUBERT BOND also referred to colony epileptics, who, however, were certified. There was no sharp line of demarcation between the sane and the insane epileptics. He agreed with the conclusions in the paper in regard to heredity. But there were other pre-natal factors beyond ordinary heredity; an appreciable proportion of his cases were either difficult labour cases or were primiparous, and many had had very juvenile parents. The age of onset in relation to prognosis was a very complex question. The four groups of cases, arranged according to their present mental condition, should themselves be subdivided into sub-groups arranged according to the present ages of the cases in quinquennia; and to allow of this of course necessitates a much larger number of cases. There was too great a proneness to regard the fits as the essential disease. The nature of the disease was still unknown.

Dr. TURNER, in reply, said that although his statistics were based on so-called sane epileptics, yet a large percentage showed marked degrees of mental impairment. It was not possible to define the epileptic face in precise terms. He was inclined to support in some cases the auto-intoxication theory of the cause of epilepsy. Almost the most important factor in heredity was the question of alcoholism in the parents.

THE ECONOMIC VALUE OF THE SANATORIUM TREATMENT FOR THE WORKING CLASSES

BASED UPON AFTER-HISTORIES

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PHYSICIANS TO MUNDESLEY SANATORIUM

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THE following paper is devoted to a consideration of the life-histories of twenty-eight consumptive patients who were treated in the Sheffield Royal Infirmary between June, 1899, and March, 1900, at which time the writers were respectively House Physician and Clinical Clerk. This work on the so-called sanatorium or open-air principles was primarily more or less of an experimental character, and at the time it was commenced there was not considered much likelihood of its proving sufficiently satisfactory to warrant it becoming a permanent department of the hospital's routine work. The results obtained were, however, surprisingly good, but considerable doubt

was felt by all who followed the work as to its clinical success proving of much permanent value, doubts which of course time alone could either confirm or dissipate. Four years have now elapsed since the majority of these patients were discharged, and throughout this period we have carefully followed their varied fortunes. The after-histories that we have thus been able to obtain are of considerable interest both on clinical grounds and from the point of view of social economy; but before detailing them it is perhaps best to describe briefly the clinical condition of these patients before and after treatment, and also to give some idea of the lines of treatment adopted and of the conditions generally—*e. g.* climatic, administrative, structural, etc.—under which it was carried out.

General Conditions under which the Treatment was carried out.

Accommodation.—Previous to June, 1899, the few consumptive patients admitted to the infirmary had been treated in the general medical wards, but after it had been decided to try the open-air treatment this was given up and arrangements made for the separation of the consumptives from the other patients. This course was indicated both on the grounds of risk of infection to other patients and on account of the obvious impossibility of efficiently carrying out the open-air part of the treatment in a mixed hospital ward. The accommodation which was then provided for the consumptives consisted of two ordinary medical wards, which were devoted exclusively to their use. These wards were of the old-fashioned type, provided with a good number of sash windows on each side reaching fairly low to the ground; they faced respectively east and west, were heated by open fire-places, and had no other ventilation besides that afforded by windows and doors. There were no balconies attached to these wards, so that patients who were treated in bed from time to time had to remain in the ward themselves, their beds being drawn up

to the windows to allow of their getting as much air and sunshine as possible. Those who were sufficiently convalescent spent their day in a part of the infirmary grounds, about half an acre in extent, on which one revolving shelter, large enough to accommodate four patients, was reserved for the worst of the cases who were treated out-of-doors. The rest of the patients simply lay out in the open on deck chairs, protected from the wind by screens and well provided with rugs and warm clothing during the winter.

Routine, administration, etc.—The general principles of the sanatorium treatment are now so widely known that it is unnecessary to say much about the routine adopted. The main essentials of the treatment were thoroughly carried out, viz. a maximum amount of open-air, an adequate diet, regulated rest and exercise. In addition the routine included daily bathing, massage in the case of patients confined to bed, and the administration of drugs when indicated. Guaiacol and creasote were tried in several cases with no apparent benefit. The patients spent their whole day from 7 a.m. until dusk in the grounds, except in bad weather, when they remained in the wards all day, the windows of which one need scarcely say were always open. The ordinary clinical records of a teaching hospital were kept. The supervision of the patients was of course not so constant as in the present-day sanatorium, since the charge of the open-air wards formed but a small portion of the duties of the resident medical officer; still, with a staff of a sister and three nurses, little difficulty was experienced in seeing that patients for the most part carried out their daily instructions.

Dietetic arrangements.—Patients had three chief meals, viz.: Breakfast at 6·30, consisting of porridge, bacon and eggs or fish, and bread and butter, with half a pint of milk. At 10.30, milk, half a pint. Dinner at 12.30, consisting of meat and two vegetables, milk pudding and fruit, and half a pint of milk or beer. Tea at 4.30; bread and butter or jam, and an egg, with half a pint of

milk and tea. Supper at 7 p.m.; much the same as a breakfast, with half a pint of milk. Half a pint of milk was also allowed for each patient during the night.

Climatically.—The treatment was carried out under the unfavourable conditions which are of necessity associated with a big centre of metal industry. The infirmary itself lies low, and is in close proximity to some of the largest of the Sheffield steel works. It is in consequence, as often as not, more or less enveloped in smoke, and frequently, during the winter, in thick fog.

Class of case admitted for treatment.—The cases admitted were quite unselected, with the result that the proportion of patients with a really good prognosis was very small. No less than eleven, or 39 per cent., of the twenty-eight admissions were clinically hopeless cases, and only sixteen, or 57 per cent., appeared to have a chance of being restored to a fair working capacity. The type of really early case, viz. with a single apical lesion and no constitutional disturbance, from which class by far the greater number of successes is obtained (the proportion of these cases in whom the disease is permanently arrested being in our experience from 80 to 90 per cent.), had but one representative amongst our twenty-eight patients. The very small number of this, the most favourable type of consumptive, is accounted for by the great difficulty we experienced in finding them. At the date this work was done, viz. 1899, very few early cases were seen in the out-patient department, and those that were diagnosed invariably elected to continue at work until they felt ill enough in their own opinion to warrant their going into hospital.

The following table gives a brief summary of the twenty-eight admissions, the basis of classification being the duration of the disease and the extent of the lesion.

Duration of phthisis.	No. of cases.	Average no. of lobes affected.
Six months . . .	8	2 or 3.
Six to twelve months .	8	3 or 4.
Twelve months, or more .	12	4 or 5.
	28	

This table shows the large proportion of our cases who had extensive disease of considerable duration, and since the prognosis for complete arrest in cases of pulmonary tuberculosis is, *cæteris paribus*, proportionately less favourable, the larger the area of lung affected and the longer the duration of the disease, it is clear that from the outset we could not look for very flattering results, as shown by statistics. It is as a matter of fact very difficult to express adequately in tabular form either the exact class of case admitted or the results obtained from any form of treatment of pulmonary tuberculosis, since the probabilities of complete recovery vary so enormously in different clinical types of the disease; for instance, while 50 per cent. of cases completely arrested and restored to health would be a poor result of the treatment of a hundred carefully selected early cases, a smaller percentage of complete recoveries would be a very fair one supposing the patients were unselected and included a good number with extensive or old-standing disease. It is necessary, then, when discussing admissions and preparing statistics of results, to classify the cases treated according to their several types and probable prognosis, if the figures are to give a fair indication of the degree of success obtained. The classification of types of pulmonary tuberculosis is unfortunately in itself a matter of considerable difficulty, and no method has as yet been generally adopted by writers upon this subject. The classification we have used in this paper is that described by Fowler, which is based upon well-defined pathological distinctions (Fowler and Godlee, pages 318 *et seq.*). Fowler recognises four types of the disease, (1) miliary, (2) caseous, (3) fibroid, and (4) fibro-caseous or chronic disease: miliary being marked by rapid caseation of miliary tubercles throughout the lung; caseous tuberculosis by rapid caseation of the affected areas associated with a rapid course, the so-called galloping consumption; fibroid disease, characterised pathologically by fibroid transformation of miliary tubercles without caseation, associated with a very slow course—Andrew Clarke's fibroid phthisis;—and

fibro-caseous or chronic disease, characterised by a varying degree of the pathological conditions just described, viz. caseation and fibrosis, and represented clinically by an infinite variety of conditions depending upon the relative degree of activity or arrest of the disease. To this last class belong the large majority of cases that come under the care of the sanatorium physician, and in view of the great differences that exist in patients of this type, it is necessary to attempt some further classification of them. The best basis for such a sub-division appears to be one founded upon the duration and the extent of the disease, the degree of activity or arrest present, and the probable recuperative power of the patient as indicated by the digestion, general health, etc. Finally, patients who have in addition disease in other organs must be considered separately. The following table, I, gives a summary of our admissions classified on these lines :

TABLE I.

Type of case.	No.
Miliary	2
Caseous:	
Acute	1
Subacute [1]	3
Fibroid:	
Fibro-caseous or chronic:	
A. Limited lesion, no constitutional disturbance	1
B. Fairly recent and extensive active disease of two or three lobes, considerable constitutional disturbance, *e. g.* fever, sweats, emaciation, etc.	5
C. Very extensive active disease of four or five lobes, some nine to twelve months' duration; high fever; dyspepsia; much emaciation; sweats, etc.	4
D. Extensive chronic disease of long standing, one year or more; considerable fibrosis; less activity; general health impaired	10
Complicated:	
Larynx, tuberculous disease of	1
Lardaceous disease	1
	28

[1] Fowler remarks that cases are often observed intermediate in

Results of treatment.—The next table gives a brief summary of the condition of the twenty-eight patients on admission, their condition on discharge, and the ultimate results obtained as shown by their after-histories during the subsequent four years. It is difficult in a few words to state the exact condition of each patient on discharge, but obviously the inferences to be drawn from the after-histories will be much more reliable if one can make clear the probable prognosis of each patient when discharged. The terms cure, partial cure, arrest, improved, etc., have been used so loosely by various writers that it is best for us to first define the terms we use as indicative of the various degrees of improvement. By arrest we imply that the physical signs indicate a definite diminution of the activity of the disease, but this improvement may be anything from a slight change for the better to complete clearing up of all physical signs except those compatible with a healed lesion. The following are the definitions of the terms we have used in this paper:

Complete arrest: Complete restoration of general health; no adventitious sounds, or only such as are compatible with a completely healed lesion.

Partial arrest: (*a*) General health completely or nearly completely restored; some adventitious sounds, perhaps only on cough. (*b*) General health imperfectly restored, but toxic symptoms and fever absent; adventitious sounds fairly numerous.

No improvement: Disease still progressive and active.

As will be seen from the table of results, the cases of miliary and caseous disease, six in number, failed to make any improvement under treatment, and their average length of stay in the infirmary was four and a half months. The remaining twenty-two patients, who belonged to the

severity between these types and those classified as cases of chronic pulmonary tuberculosis. They are characterised by the same tendency to caseation of the lesions, but the progress of the destructive changes throughout the lung is less rapid. Cases of this kind we define as sub-acute.

TABLE II.

	Name.	Condition on admission.				Result of treatment.
		Fever.	Dyspepsia.	Sweats.	H. K. W.[1]	Clinical result.
		MILIARY.				
	S.	102—104	Present	Present	Too ill to weigh; much emaciation	Death
	J. T.	96·6—102·3	Present	Present		Death
		CASEOUS.				
Acute	F.	98—102·5	Present	Present	Too ill to weigh; much emaciation	Death
Subacute	G.	100—101	Present	Present	Unknown, but obviously very considerable	—
	S.	100—101	Present	Present		Death
	R.	99—101	Present	Present		Death
		FIBRO-CASEOUS.				
Limited lesion; no constitutional symptoms	R.	*Nil*	*Nil*	*Nil*	— 14 lbs.	Complete arrest
Fairly recent and extensive active disease, two or three lobes, considerable constitutional disturbance, *e. g.* fever, sweats, emaciation, etc.	S.	98·6—102	Present	Present	— 24 lbs.	Partial arrest, A
	E. T.	98·6—99·4	*Nil*	*Nil*	— 12 lbs.	Partial arrest, A
	P.	99—101	*Nil*	*Nil*	— 21 lbs.	Partial arrest, A
	J.	98·5—100·2	Present	Present	— 14 lbs.	Partial arrest, I
	W.	99—100·5	Present	Present	— 20 lbs.	Partial arrest, I
Very extensive, active disease, four or five lobes, of some 9—12 months' duration, high fever, dyspepsia, much emaciation, sweats, etc.	D.	99—101	Present	Present	— 14 lbs.	Temporary improvement, subsequent death
	R.	99·5—102	Present	Present	— 28 lbs.	
	D.	98—101	Present	Present	— 56 lbs.	
	F.	98—101·2	Present	Present	— 22 lbs.	Partial arrest, I
Extensive chronic disease of long standing, one year or more, considerable fibrosis, less activity, general health impaired.	B.	*Nil*	*Nil*	*Nil*	— 23 lbs.	Partial arrest, A
	B.	98·4—100	*Nil*	*Nil*	— 20 lbs.	Partial arrest, I
	H.	98·2—100·2	*Nil*	*Nil*	— 20 lbs.	Partial arrest, A
	A.	*Nil*	*Nil*	Present	— 28 lbs.	Partial arrest, I
	W. T.	*Nil*	*Nil*	*Nil*	— 18 lbs.	Partial arrest, A
	G.	101—104	*Nil*	*Nil*	— 28 lbs.	Partial arrest, A
	F.	98—101	Present	Present	— 18 lbs.	Partial arrest, I
	S.	98·8—101·4	*Nil*	Present	— 42 lbs.	Partial arrest, I
	S.	98·5—100·2	*Nil*	Present	— 12 lbs.	Complete arrest
	G.	*Nil*	Present	*Nil*	— 20 lbs.	Partial arrest, I
Complicated cases	S.	98—100·5	Present	Present	Unknown	Death
	H.	*Nil*	—	*Nil*	— 25 lbs.	Partial arrest, I

[1] H. K. W. = Highest known body weight previous to contracting tuberculosis.

TABLE II.

Result of treatment.	After-history.			
Gain in weight.	One year.	Two years.	Three years.	Four years.
MILIARY.				
Nil.				
Nil.				
CASEOUS.				
Nil.				
Nil.				
Nil.				
Nil.				
		FIBRO-CASEOUS.		
12 lbs.	Normal health, at full work	Normal health, at full work	Normal health, at full work	Normal health, a full work
23 lbs.	Normal health, at full work	Normal health, at full work	Normal health, at full work	Normal health, a full work.
22 lbs.	Normal health, at full work	Normal health, at full work	Normal health, at full work	Normal health, a full work.
17 lbs.	Normal health, at full work	Normal health, at full work	Normal health, at full work	Normal health, a full work.
16 lbs.	Poor health, no work	Death.		
16 lbs.	Death.			
16 lbs.				
11 lbs.				
15 lbs.				
19 lbs.	Death.			
20 lbs.	Fair health, some work	Death.		
19½ lbs.	Fair health, full work	Fair health, full work	Fair health, full work	Death.
24 lbs.	Fair health, some work	Death.		
3 lbs.	Fair health	Fair health	Fair health	Fair health.
18 lbs.	Very fair health, some work	Normal health, full work	Normal health, full work	Lost sight of.
23½ lbs.	Sound health, some work	Sound health, some work	Lost sight of.	
18 lbs.	Fair health, full work	Death.		
9 lbs.	Death.			
26 lbs.	Death.			
17 lbs.	Fair health, some work	Fair health, some work	Worse, no work	Death.
3 lbs.				
20 lbs.	Death.			

chronic or fibro-caseous type, all benefited by treatment, though in several cases the improvement was only of a temporary character. Taking them group by group according to our classification, the only representative of Group 1 characterised by a single lesion and absence of any constitutional disturbance was discharged completely arrested after a stay of four and a half months, by which we imply that he had no physical signs except those that are compatible with a healed lesion, and that his general health was completely restored. In the next group, comprising cases of fairly extensive active disease of some three or six months' duration, with a fair amount of fever and other toxic symptoms, there were five patients. These were all considerably emaciated, and on the average each weighed seventeen pounds below his highest known weight. Their temperatures on the average ranged from 98·6° F. a.m., to 100·6° F. p.m.

These patients all did well under treatment; three were discharged incompletely arrested with very slight signs of disease remaining and general health completely restored, in fact quite fit to return to work. The other two were not so much benefited, their health being but partially restored and their disease very incompletely arrested, moist sounds being still fairly numerous. The average length of stay of these five cases was five and a half months, and their average gain in weight was eighteen pounds. The next group contains four patients, all with very extensive active disease of either four or five lobes of some twelve months' duration, associated with very acute symptoms. The average temperature ranged between 99° F. a.m. and 101·5° F. p.m.; and they averaged thirty pounds each below their highest known weights. The prognosis on all these patients was a very grave one indeed, short of being hopeless. Three of these improved considerably up to a certain point, on the average gaining fourteen pounds each and becoming more or less convalescent, but all subsequently relapsed either before or soon after discharge, and died respectively from laryngeal disease, exhaustion

following infection of the intestines, and miliary tuberculosis. The fourth improved sufficiently to allow of his return to light work, but he relapsed and died a few months after discharge. These four patients were on the average under treatment in the infirmary eight and a half months each, so that from a financial point of view they proved very unsatisfactory cases to admit. Under the next group, in which are included all the chronic cases of a year or more's duration, we have classified ten patients whose clinical conditions varied considerably. The majority had fairly extensive disease, associated with a considerable degree of arrest and fibroid change. In every case the general health was decidedly impaired, which, though scarcely bad enough to negative work absolutely, made them unfit for anything like the normal routine of a healthy working man. Four had definite fever, but the remainder were afebrile; they were all considerably emaciated, on the average each being twenty-three pounds below his highest known weight. As a result of treatment, one patient left apparently completely arrested and quite fit for work; four were restored to a full working capacity, though their physical signs had but partially cleared up, the best type of incomplete arrest; the remaining five were discharged with the disease very imperfectly arrested and general health still far from satisfactory. The average gain in weight of these ten patients was eighteen pounds. Of the two complicated cases, the one with laryngeal disease, though he gained a few pounds in weight, never really improved; the case of lardaceous disease, however, improved considerably, putting on twenty pounds in weight and regaining a fair degree of health; he returned to light work, but soon relapsed and died. Reviewing the results as a whole, we see that eleven, or 39 per cent., of our patients were practically hopeless on admission, and that the satisfactory results were obtained in patients either with fairly recent active disease or with chronic slowly progressive mischief of considerable duration. Of the sixteen patients who belonged

TABLE III.—*Showing Economic and*

Name.	Working capacity on discharge.	Wages.	Employment.	Home conditions.
S.	Full	20/- per week; insufficient	Bad	Bad
B.	Full	Sufficient	Unsuitable	Satisfactory
H.	Full	Insufficient	Unsuitable	Very fair
G.	Full	Sufficient	Bad; worked short hours	Poor
P.	Full	Sufficient; 24/- per week and grants of food	Very good	Good
S.	Full	Sufficient; 35/- per week	Risky, but proved suitable	Very good
T.	Full	Sufficient	Eventually good	Very good
R.	Full	21/- per week; sufficient	Good	Good
T.	Full	Sufficient	Good; emigrated	Good
B.	Partial	Sufficient	Very good	Good
F.	Partial	Sufficient	Fairly suitable	Good
S.	Partial	Insufficient	Bad	Poor
G.	Partial	Sufficient	Fairly suitable	Good
J.	Partial	Insufficient	Never worked	Very bad
A.	Partial	Sufficient	Married woman	Very good
F.	Partial	Unknown	Unknown	Unknown

Social Conditions after Discharge.

Social conditions.	Ultimate result (up to four years after discharge).
Wife and one child dependent on him	Died twelve months after discharge.
Unmarried; no one dependent on him.	Worked irregularly for nine months; died within year and a half. Aneurismal hæmoptysis.
Three children; widower	Irregular work for a year; died eighteen months after discharge.
Unmarried; no one dependent on him	In good health and at work when last heard of.
Wife and five children dependent on him	In excellent health and at full work.
Unmarried; no one dependent on him	In excellent health and at full work.
Unmarried; no one dependent on him	In good health and at work when last heard of.
Unmarried; gave 4/6 per week towards support of mother	In excellent health and at full work.
Unmarried; no one dependent on him	In excellent health and at full work.
Unmarried; no one dependent on him	Worked three and a half years; disease slowly progressive; died November, 1903.
Unmarried; no one dependent on him	Did a full day's work for a year, then relapsed and died.
Wife and four children dependent on him	Died during the first year after discharge.
Wife and three children dependent on him	Worked two and a half years; disease progressive; died November, 1903.
Widowed mother and one child dependent on him	Died twenty-two months after discharge.
Husband in a good position	Continued the treatment, looks after her home; health better now than at any time since discharge.
Married	Died seven months after discharge.

to one of these two classes, nine were discharged restored to their full working capacity, and seven were sufficiently improved to allow of their return to light work. One of the hopeless cases, viz. the one with lardaceous disease, was also able to return to work for a short time. These results, in our opinion, were quite satisfactory, and in fact compared very favourably with what subsequent experience has taught us to expect from treatment carried out under the best possible conditions.

Ultimate or Economic Results, based on After-Histories.

The after-histories of these sixteen patients who were either completely or partially restored to health and their normal capacity for work are of considerable interest as evidence of the economic value of the sanatorium treatment for the consumptive working-man, for it is clear that however satisfactory the immediate clinical results of treatment of such cases may be, many factors quite outside the province of medicine militate against the chance of many remaining permanently arrested and proving in the fullest sense of the term economic cures. Table IV gives a summary of the after-histories of our sixteen patients who returned to work, the statistics covering a period of four years subsequent to their leaving the infirmary, and since we are now dealing more especially with the economic aspect of the Sheffield work we have classified them according to their various wage-earning capacities during this period, rather than on the basis of their several clinical conditions.

At the end of the first twelve months three were dead, two of the deaths occurring amongst those only partially restored to a working capacity and one amongst the fully restored; the remainder were all still at work, six doing a full day and six something less than an ordinary full day's work. At the end of the second twelve months there had been four more deaths, two occurring in the partially

restored and two amongst the fully restored patients. Six patients were still in excellent health and doing a full day's work, while three were sufficiently well to do light work. At the end of the third year all of these nine patients, so far as we were able to ascertain, were maintaining their health and still at work. One patient unfortunately could not be traced, but the last reports we had of him were quite satisfactory. Four years after their discharge five of these nine patients were still at work, two of the remaining three, who had only been partially restored to health, were dead, and another patient, whose condition when last seen had also been extremely satisfactory in every respect, could not be traced. To summarise (vide Table IV), in the course of four years, of the nine patients who were restored to their full working capacity, three died, two were lost sight of, during the third and fourth year respectively (their condition when last heard of being in every way satisfactory), and the remaining four maintained their health and were at full work throughout. Four patients, then, certainly, and possibly six of the nine now under consideration have successfully withstood the strain of four years' work, and judging from the condition of the two who were lost sight of we think it extremely probable that both of them may be still in good health. The record of the seven patients who were only partially restored to health is less satisfactory, since the expiration of four years finds only one of them alive, though up to the end of the third year three of them had remained well enough to do a certain amount of work. These results must in our opinion be considered quite satisfactory, especially when one bears in mind the clinical condition and social status of which these sixteen patients were representative. The proportion of permanent successes would doubtless have been greater had the social conditions returned to in several instances been as satisfactory as the clinical condition on leaving.

Indeed, the experiences of our patients have impressed us with the impossibility of permanently benefiting con-

TABLE IV.—*Table of After-histories of Sixteen Patients discharged either Fully or Partially Restored to their Full Working Capacity.*

	One year.				Two years.				Three years.				Four years.			
	Good health and full work.	Poor health; some work.	Lost sight of.	Death.	Good health and full work.	Poor health; some work.	Lost sight of.	Death.	Good health and full work.	Poor health; some work.	Lost sight of.	Death.	Good health and full work.	Poor health; some work.	Lost sight of.	Death.
Full restoration, 9 patients	4	4	—	1	5	1	—	2	5	—	1	—	4	—	1	—
Partial restoration, 7 patients	2	3	—	2	1	2	—	2	1	2	—	—	—	1	—	2
	6	7	—	3	6	3	—	4	6	2	1	—	4	1	1	2

sumptives whose social status does not permit of their living and working under at least fairly favourable conditions after their disease has been arrested. The factors which have been chiefly instrumental in determining the ultimate results obtained in our patients are of sufficient interest to warrant a brief notice, and for this purpose we have prepared a summary of the social and economic conditions to which the sixteen patients returned after their discharge, with a note as to the amount of work they each did during the subsequent four years; the first half of the summary giving the details with regard to the nine patients who were fully restored to their normal working capacity, and the latter half dealing with the seven who were only partially restored. Considering the fully restored patients first, who on clinical grounds all had an equally good prognosis, we see that three relapsed and died within eighteen months. These three had all returned to unsuitable employments, and, in addition, two were unable to make an income adequate for their wants, both being married men with a wife and family to support. If these two had been single men with no one dependent on them their chance of remaining permanently arrested would have been very much greater. The other failure amongst those fully restored was unmarried and had no one dependent on him, but unfortunately he developed a pulmonary aneurysm, so that the work he returned to, viz. that of farm labourer, proved unsuitable, and was the direct cause of his relapse and subsequent death. The remaining six fully restored patients, who, being still at work, have proved economic successes, had all certain important factors in their favour; they all had adequate incomes, and in every case the nature of the employment they returned to proved suitable. Four of them, in addition, were single men with no one dependent upon them, and, with one exception, they all had very comfortable home conditions. With respect to the seven who were partially restored to health, one was soon lost sight of, and nothing is known of him except the date of his

death. Two were bread-winners of their families, which had no other possible source of income except parochial relief, and both had unsatisfactory occupations which they were unable to exchange for anything better. The combination of these two adverse factors soon brought about relapse and death. The remaining four all returned to more satisfactory social conditions. One was a married woman in comfortable circumstances, who, continuing the treatment at home, made further progress, and at the present time is in very fair health. Two were young men still living at home who had no need to return immediately to work, since other members of their families could afford to keep them. They both, however, elected to take on some light work. One of them became hall-porter at the Sheffield Medical School, and remained in very good health all through his first summer, but in the winter he relapsed, and died about twelve months after his discharge. The other obtained very suitable employment as rate collector, and did very well indeed till an injudicious bicycle ride brought on hæmoptysis, which resulted in his losing his place. He resumed work as a clerk, and though his health was gradually failing he managed to make a very fair wage, working in all for three and a half years after his discharge. The remaining case had a wife and family which he would have been quite unable to support for any length of time after leaving the infirmary. Fortunately his wife had started a small shop when his health first broke down, and the income which she derived from this source was sufficient to keep them in fair comfort. The patient himself was able to make some addition to the family income for two and a half years by (commercial) travelling in cigars and helping in the shop. The disease, however, was slowly progressing, and he died in the fourth year after his discharge. The occupations and social conditions of these last two were satisfactory enough, and but for the seriousness of their clinical conditions they might very well have had satisfactory after-histories; under less favourable conditions neither

would have lived, much less worked, anything like as long as they did. It is noticeable that of the seven patients whose disease was very imperfectly arrested only one, viz. a married woman, is now alive, and her immunity from disaster is unquestionably due to her having a comfortable home and ample opportunities of looking after her own health.

The Influence of Occupation.

The nature of the employment on which the arrested consumptive depends for his livelihood has such a very important bearing upon his future, and is so frequently more or less the direct cause of his subsequent relapse, that a decision as to the kind of work he should return to becomes one of paramount importance. Our patients were almost without exception drawn from injurious occupations, so from the first we made every effort to persuade them to try and obtain suitable work after their discharge. This, however, usually proved a matter of some difficulty, unless the patient could afford to make some financial sacrifice. Occupations injurious in character, although for the most part well paid, are the rule in a manufacturing city like Sheffield, and remunerative employment suitable for cases of arrested tuberculosis quite the exception. On the whole, then, we were surprised with the degree of success which rewarded the efforts of our patients to change their work and yet earn a wage adequate for their wants. The following table, V, gives the occupations of all the patients admitted to the open-air wards :

TABLE V.

	No.
(1) Indoor work:	
Workers in metal shops	8
Workers in engineering shops	3
Clerks	4
Shop assistants	2
Cabinet-maker	1
Coal-miner	1
Workhouse hospital attendant	1
Box-maker	1
Female patients:	
Machinist	1
Housework	3
	25
(2) Outdoor work:	
Rate collector	1
Errand boy	1
Stonemason	1
	3
Grand total	28

From this table it is seen that, excluding the four women, whom it is less important to consider from the point of view of occupation, since for the most part they are engaged in looking after their own household work, there were twenty-four men admitted, and out of these no less than twenty-one had indoor employment, most of it of a distinctly unhealthy nature. The possible exception was that of the workhouse hospital attendant, but since consumptive patients were by no means uncommon cases in his wards, which were devoted to pauper invalids of weak intellect, his work can hardly be called suitable. Of the remaining three who had out-door employment, two, viz. the errand boy and the rate collector, could

scarcely have done better in the town; but the occupation of the third, viz. a stonemason, was open to almost as much objection as that of any indoor employment. Taking them all together, then, no less than twenty-two out of the twenty-four men admitted were dependent for their livelihood on occupations which it would be undesirable for a case of arrested tuberculosis to return to, and the probabilities of anything like all of them being able to change their work for something more suitable and at the same time equally profitable were of course extremely remote. This fact illustrates very clearly the very great odds that the consumptive workers in cities have to contend with, and how very readily clinical successes may from the outset be doomed to ultimate failure on account of adverse social and economical after-conditions. Of these twenty-four, however, only fifteen on their discharge actually resumed work, and of these no less than twelve, or 80 per cent., changed their employment, a remarkably high proportion. The following table, VI, gives the original work of these fifteen and the nature of the employment they returned to, with the result of the same.

Of the three men who returned to their original employments, two, viz. the cycle mechanic and the stonemason, quickly relapsed, although the former was a very promising case on purely clinical grounds. The one who did well, viz. the metal grinder, was a very slight case indeed, and being a skilled workman with no one dependent upon him, he was able to keep himself though working only short hours. Of the twelve who changed their work, four relapsed and died within eighteen months. The occupation of one of these is unknown, and of the remaining three, two became respectively farm labourer and caretaker, while the third at first drove a van, but later got work in a bakehouse. In at least two of these three cases the nature of the work itself was largely responsible for their relapse; the work of the farm labourer was much too heavy and brought on recurrent hæmoptysis, and the work in the bakehouse was obviously

TABLE VI.

Name.	Original trade.	Trade returned to.	Success or failure.
G.	Metal grinder	Same work, shorter hours	Success.
S.	Cycle mechanic	Same work	Failure.
S.	Stonemason	Same work	Failure.
F.	Cabinet-maker's assistant	Porter in medical school	Partial success.
F.	Metal-smith	Assisted in wife's shop	Failure.
R.	Coal-miner	Telephone company's labourer	Success.
T.	Grocer's assistant	Emigrated to Australia; odd jobs	Success.
S.	Steam-hammer driver	Steward of working-man's club	Success.
T.	Type founder	(1) Commercial traveller (2) Tram conductor	Failure. Success.
B.	Silver spinner	Emigrated; farm labourer, etc.	Failure.
B.	Office clerk	(1) Rate collector (2) Office clerk	Success. Failure.
P.	Workhouse hospital attendant	(1) On workhouse farm (2) Workhouse attendant (general)	Failure. Success
G.	Silversmith	(1) Commercial traveller (2) Assisted in wife's shop	Partial success. Success.
H.	Box-maker	(1) Van driver (2) Worked in a bakehouse	Success. Failure.
H.	Clerk	Caretaker	Died soon; death independent of nature of work.

unsuitable, and a poor exchange if a more profitable one than that of driving a van. The caretaker died of lardaceous disease, but his death was certainly not accelerated by his change of work. The satisfactory occupations were those of telephone company's labourer, steward of workingman's club, tram conductor, rate collector, attendant of workhouse infirmary, van driver, hall porter, and doing odd jobs in Australia. In every instance these occupations were undertaken for the first time after the patient's discharge, changes for the better which have undoubtedly had a large share in the ultimate successes which have been obtained. Commercial travelling, to which two returned, was on the whole a failure, since neither of the patients could afford to drive on their rounds, and the consequent walking and carrying heavy samples made this life a good deal too arduous. It will be noticed also that both the patients who took employment on farms found the life unsuitable for them. This is of interest as showing that such work may be even less satisfactory than that of a much less open-air character. When advising patients to take up work on a farm, it is advisable to warn them of the danger of heavy manual labour, for while there are certainly many light jobs to be found on farms, such as attending horses, driving carts, etc., the ordinary farm labourer is not of much use unless he can undertake any job however heavy that at the time may want doing. In our experience ordinary farms do not offer much scope for employment of the tuberculous worker from a city. The majority of our patients who changed their work certainly for some time lost financially by so doing, but the fact that they were mostly unmarried made this a matter of much less importance than it would have been if they had had families dependent upon them. It may be noted also that of the patients who are at the present time still at work, all but one had distinct social advantages in that they had comfortable homes and sufficient financial support from one source or another to keep them in comfort for some time in the event of their relapsing,

and to this fact, inasmuch as it implies a more comfortable scale of living, their immunity from relapse is no doubt to some extent due.

Conclusions.

The results of this work appear at first sight to afford no very conclusive evidence as to the proportion of economic cures one may expect when treating the consumptive working classes. In the discussion on the sanatorium treatment ('Med.-Chir. Trans.', vol. iii) Dr. Fowler quotes the views of Dr. Walther, of Nordrach, on this question, viz. that "patients do well when they are in the sanatorium, but when they go home and recommence work in many cases they immediately relapse," and on the whole Dr. Walther considered that "such patients lived a shorter time than if they had not undergone the treatment." We are quite in accord with this opinion in as far as it refers to the great benefits which the working classes obtain from suitable treatment and the great risk there is of their subsequently relapsing, especially if they return to unhealthy occupations. The ultimate results of the Sheffield work and subsequent experience have convinced us, however, that sanatorium treatment for the poor is by no means so hopeless or useless as Dr. Walther seems to imply. With one exception, all the patients treated at Sheffield were in such a condition that a continuance of work would soon have found them in a hopeless condition, both clinically and economically, and, moreover, dangerous sources of infection to their families and fellow-workers. Timely treatment undoubtedly restored to a full working capacity, as proved by the records of the last four years, six men who almost certainly would not otherwise have been alive, much less earning their living, at the present time. Several others also, whose condition on admission negatived any hopes of their disease being completely or permanently arrested, had undoubtedly their fairly useful lives considerably prolonged as a result of the immediate

and educational benefits they derived from the treatment. In no instance do we consider that a patient lived a shorter time than if he had not been treated at all; on the contrary, in our opinion there was no case with any hope at all whose life was not considerably prolonged. The greatest difficulty which one has to contend against in the case of the poor consumptive is the question of work and obtaining an adequate income after treatment; and until the difficulties associated with this problem are met, much valuable work must be destined to ultimate failure. Early diagnosis also is another essential for really good results. In the case of the work now under consideration the benefits to be derived from early diagnosis were entirely absent, but this initial handicap was to some extent compensated by the degree of success which attended our efforts to make the men find suitable employment after their discharge. The work has amply demonstrated the valuable help that general hospitals can render their consumptive patients, and shows that the sanatorium treatment can be carried out with a very considerable degree of success in institutions other than those especially constructed for the purpose. General hospitals, as philanthropic institutions, cannot, however, expect a very high percentage of economic cures from the ordinary run of tuberculous case they admit, but at the same time we would not propose to exclude cases of fairly advanced tuberculosis from the benefits that such institutions can give them. We would suggest that, in addition, general hospitals should treat a few really hopeful cases on sanatorium lines, and feel assured that, by exercising a rigid selection of these patients, limiting the admissions to unmarried men with early disease who are both willing and likely to have the opportunity of returning to suitable employment, a few beds could very profitably be devoted to the treatment of the consumptive working-man.

DISCUSSION.

Dr. C. THEODORE WILLIAMS thought the paper told on the whole a sad tale. The number of cases was unfortunately small; it was hardly possible to draw satisfactory statistical conclusions from them. Of the twenty-eight cases the results seemed to him unsatisfactory. Of the sixteen that were at all hopeful only four did well. Of the cases classified as those of partial arrest several merely showed some improvement, and of nine eight died, showing that there was no ground for using the term at all. At the end of four years five cases only out of twenty-eight were still at work. Of 3,500 cases of phthisis recorded by Dr. J. E. Pollock at the Brompton Hospital with ordinary out-patient treatment the average of life was two years and six months among the 129 that died, and among the others the expectation of life was good, and the majority had the prospect of going on working for a considerable period. This did not argue well for the sanatorium treatment, which was not successful unless it was thoroughly carried out and the patient on leaving the sanatorium returned to favourable conditions of life. Not much trust was to be placed in gain of weight alone; weight came and went very easily, but we should aim at increase of muscle and nerve. The after-occupation of arrested cases was very important, and varieties of open-air life should be devised. Colonies for old consumptive patients seemed to be very desirable, and in the United States some of these existed.

Dr. J. KINGSTON FOWLER, after some remarks on the classification of cases which he had suggested and to which the authors of the paper had made reference, said that the extent of the disease was an important factor in prognosis. The pathological classification was better than a clinical. Judgment in regard to prognosis in the case of a particular patient depended on his temperament largely, and on character traits. Again, from the economic point of view, as from the philanthropic, cases should be taken early, preferably unmarried males without anyone dependent on them. Most of the cases referred to in the paper were beyond cure. The results were only unfavourable in so far as they disappointed unwarranted expectations. The pathological condition revealed at necropsies was often three or four times more extensive than the clinical signs had indicated. A very favourable after-occupation was nursery gardening. In better-class cases nearly all who broke down did so from over-exertion; for two years, as Dr. Walther held, nothing but walking exercise should be taken. He also advocated colonies

for the cases in which the disease was arrested. He still considered that the open-air treatment gave the best results.

Dr. F. RUFENACHT WALTERS thought the duration of the treatment was a very important point. Most of the cases recorded in the paper required a longer course than they had had. The gained fat should be converted into good muscle; girth might decrease while weight was maintained. The cases at Sheffield were treated for too short a time. For an early case the German idea that three months' treatment was sufficient had been abandoned. Only about ten per cent. of the cases seeking sanatorium treatment were really early cases.

Dr. T. GLOVER LYON had inquired of twenty hospital patients that had undergone improvement, and of these not one had returned to work. Better results were obtained from indoor treatment, but these were of questionable advantage from an economic point of view in the case of a working man, as he could not go on with his work, and usually got into lazy habits.

Dr. A. NEWSHOLME thought the economical part of the question had a wider bearing from the public health point of view. Thus a married man was more suitable for treatment than the unmarried because more depended on him, and he had more opportunities of disseminating infection. The chief value was less therapeutic than educational. The extreme importance came out very strikingly in working a system of voluntary notification. He had often seen the wife and children infected with tubercle by a tuberculous father. Even one month's educational treatment was probably of more value from the economic point of view than three months' curative. The importance of early diagnosis could not be over-estimated; in many towns an examination of the sputum could be made gratuitously, and an examination should be made of the sputum in every case of intractable cough.

Dr. P. HORTON-SMITH thought from the individual point of view the early cases should be subjected to treatment; but how were they to be got into the sanatoria? Perhaps the Friendly Societies might help by giving the patients full pay during the treatment. Change of occupation was a difficult thing; a labour bureau organised by philanthropic societies might help. In relation to statistics an examination of the sputum for bacilli should be appended in the slight cases, otherwise doubt might be cast on the validity of alleged cures.

The PRESIDENT, in reference to general hospital treatment of tuberculosis, thought that for prolonged treatment it was unsuitable. But it was very valuable for the acute phases, and for intercurrent affections in tuberculosis. Moreover, all patients might well have a probationary period in a general hospital, or in a large chest hospital for a few weeks' observation before being passed on to the sanatoria. This would probably be the ideal plan. If every large hospital in London could supply three

or four beds for such a purpose much might be gained. Of the after-care of cases not much could be learned from small numbers of cases. Patients must be divided into those without claims on them and those with responsibilities. The aim should be to afford as good aseptic conditions as were obtained in the sanatorium. If occupation was essential, a change to outdoor life was indicated. In some of the latter class other members of the family might help. There was great need for the founding of village colonies for the benefit of patients who had had some months of definite sanatorium treatment; the expense on the rates would not be very great. While the earlier cases were more hopeful, yet the severer cases deserved treatment and sympathy; they were of a certain value to civilisation, if of no economic value; they included such names as Robert Louis Stevenson and John Richard Green. These were, however, as a rule, unsuitable for sanatorium treatment; they needed treatment in hospital wards. Physicians should not be too economically minded in regarding these cases. The economic output should not be the only outlook of a hospital; relief of symptomatic suffering was one of the highest functions of hospitals.

Dr. WILLIAM EWART also thought that general hospitals should undertake the treatment of a certain number of consumptives. They had remedial, educational, and, above all, medical educational functions. The last had not been sufficiently emphasised. Our aim should be to elaborate a treatment which should greatly shorten the duration of cases and lessen the mortality; and to this end the facilities afforded by our great hospitals, the clinical workers, and the clinical material were all equally essential.

Dr. G. NEWTON PITT saw so many cases improve under open-air treatment and retrograde afterwards that the need for colonies for patients after treatment seemed urgent, where they could be put to earn their living under hygienic conditions; there was great difficulty in finding suitable employment for partially cured patients. Some broke down from overwork, others seemed to suffer from the difficulty in a town life of satisfying the increased craving for pure air, and the cost of the larger appetite which had developed in the sanatorium. The London infirmaries, Friendly Societies, and County Councils might organise work for their tuberculous patients. For London clerks very little at present was done; a regulated colony or camp in the neighbourhood of London where they could sleep would be of great value. Occasionally moral deterioration results from sanatorium treatment in young adults, who develop habits of idleness.

Dr. BARDSWELL, in reply, said the cases recorded in the paper were very unfavourable ones, more so than the average; the social conditions seemed to turn the scale; the length of a man's purse determined his cure. Gain of weight on a physiological

diet was of great value, and was largely muscular; on forced feeding it was of less import. Loafing habits followed, it seemed, on too great carefulness over convalescent patients. The Charity Organisation Society had helped to support some cases, while at the Working Man's Cottage Sanatorium, run for some six months by himself and Mr. Chapman, in the neighbourhood of Mundesley, and these, being freed from anxiety, did very well. In all the cases recorded in the paper, tubercle bacilli were found in the sputum. There would be great difficulty in making colonies self-supporting. Tuberculous labour was unsound labour. An endowment would be needed. The crux of the social factor seemed to be largely a matter of diets, for if a working man after defraying expenses of house rent, clothes, etc., had a sufficiently good margin left with which to buy an adequate diet, he usually did well, but not otherwise.

THE SURGICAL ANATOMY

OF THE

NORMAL AND ENLARGED PROSTATE, AND THE OPERATION OF SUPRA-PUBIC PROSTATECTOMY

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So much has recently been written in regard to the operation of prostatectomy that it is with a feeling of hesitation that I add to the literature by bringing forward this record of work done during the past twelve months.

When Mr. P. J. Freyer published four cases of total extirpation of the prostate in the 'British Medical Journal' of July 20th, 1901, there appeared a volume of correspondence from which two statements stand out. Firstly, the operation of total prostatectomy had been performed before, and, secondly, the operation described by Mr. Freyer was not a total prostatectomy. With the first of these statements there is no need for me to deal. It is in regard to the second that I have pursued this investigation. At the outset it was apparent that the descriptions in our anatomical text-books formed an insufficient basis on which to work; for not only did the accounts of the

anatomy of the prostate and its surroundings vary in different descriptions, but these did not elucidate many points which were vital to the subject. It was therefore necessary to lay aside all preconceived ideas as to the surgical anatomy of the organ, and to dissect and cut sections of the prostate and its surroundings for my own instruction. I would here express my grateful thanks to Dr. Young and Dr. Goodall for affording me facilities for carrying out this work in the physiological laboratory of the Middlesex Hospital Medical School. Further, it appeared to me that before approaching the question of prostatectomy it was necessary to study the changes which took place in the relation of the enlarged prostate to its surroundings. Among others I must thank Dr. Lunn, of the Marylebone Infirmary, for adding to my material of morbid specimens of enlarged prostate.

Mr. Freyer himself kindly put at my disposal his entire collection of operation specimens, now numbering seventy-three pieces.[1] At a later date some eleven of these were presented to the Royal College of Surgeons Museum.

I have also been able to collect four specimens of the parts remaining after removal of the enlarged prostate by this method. For one of these I have to thank Mr. Swinford Edwards, another was sent by a provincial surgeon, a third was supplied by Mr. Freyer, and the fourth was from a case of my own.

From a study of this material I have endeavoured to arrive at some conclusions in regard to the anatomy of the operation of prostatectomy, and I have arranged the work under the following five heads:

I. Some points in the anatomy of the normal prostate and its surroundings in relation to prostatectomy.

II. Changes in the prostate and its surroundings in enlargement of the organ.

III. The parts left behind after prostatectomy.

IV. The structures removed in prostatectomy.

V. Observations upon the operation of prostatectomy.

[1] December, 1903.

I. Some Points in the Normal Anatomy of the Prostate and its Surroundings.

If the bladder and prostate together with the rectum and the levator ani muscles be removed from the body, the following points of importance in regard to prostatectomy may be observed.

The sheath.—I have adopted the term used by Mr. Freyer, following Sir Henry Thompson, in describing his operations, as I believe it is less likely to lead to confusion than the term capsule, which has also been used to designate another structure.

The recto-vesical fascia, on reaching the lateral aspect of junction of the prostate and bladder, is attached there, and a strong process passes downwards, covering the side of the prostate. A layer of fascia (the recto-vesical layer) passes across the posterior surface of the gland uniting the lateral layers. On tracing a lateral layer forwards it is found to pass almost to the middle line in front of the prostate and then turn outwards round the anterior border of the levator ani muscle. The lines along which these two layers turn away from the front of the prostate leave a comparatively broad space of the front of the prostate uncovered at its base. As the prostate narrows towards its apex the line of reflexion passes off from it altogether, so that the apex and about one third of the prostate does not come into relation with these lateral layers.

The front of the base of the gland between these layers is covered by a thick layer of fascia, and this, as the lateral layers pass off the lower portion, enwraps more and more of the circumference, uniting eventually with the fascia covering the posterior surface of the organ.

Thus a complete fascial sheath is provided for the prostate, which envelops it, except at its basal attachment to the bladder and at its extreme apex. Outside this sheath lie the levator ani muscles laterally, the rectum and some areolar tissue posteriorly, and a space (the space of Retzius) containing the dorsal veins of the penis and

some areolar tissue anteriorly. This fascia under the microscope shows wavy layers of fibrous tissue, which, while they are in many specimens loosely arranged, can be readily dissected and traced without a break as a definite strong membrane. The fascia covering the front of the organ is much thicker than that elsewhere, but its layers are split up by the passage of large veins, which pass upwards to the base of the organ. The openings of these veins may be seen on examining the anterior surface in a specimen removed as above described.

The relations of the base of the prostate are of importance. The outer longitudinal layer of bladder muscle is attached to the posterior border of this surface, and many fibres become incorporated with the true capsule of the gland. The sphincter vesicæ, which in some of my sections appears as a broad distinct mass readily distinguished from the rest of the circular coat, lies immediately upon the base of the gland; and above this the bundles of the internal longitudinal layer of bladder muscle stream towards the urethra and, as Thompson has shown, pass into the wall of that tube. This inner layer is strongly reinforced by two bands of muscle which pass down from the ureters and meet on the posterior wall of the vesical outlet.

If the apex of the prostate be examined, it will be found that a circular layer of striped muscle completely surrounds it for about a quarter of an inch. This muscle is continuous below with the constrictor urethræ. Passing upwards from the apex the fibres are attached laterally to the fascia, and cover only the front of the gland for a short distance. Further dissection shows that this striped muscle insinuates itself between the anterior layer of the sheath and the capsule of the prostate, and passes up the front of the prostate between the sheath and the capsule as a band of striped muscle as far as the base of the gland, uniting these two structures firmly together along the middle line. In transverse sections (Pl. I, fig. 1, *k*) this muscle is readily distinguished, and can be traced laterally

almost to the level of the urethra. The striped muscle-fibres are also continued upwards along the urethra as far as the veru montanum. This muscle, concerning which the anatomical text-books are silent, has, I find, been described by Henle.[1]

If an incision be made in the lateral aspect of the sheath, this layer of fascia may be readily stripped up from the capsule of the prostate, and the handle of a scalpel can, without force, be passed backwards between these two structures across the middle line. On passing forwards, however, it is arrested by a firm adhesion of the capsule to the sheath along the middle line. On dissecting up the sheath at this part it is found that this adhesion is formed by the band of striped muscle just described, and this must be deliberately cut through before the two layers are separated.

The prostatic venous plexus.—Examination of the anterior layer of the prostatic sheath shows two or sometimes more openings leading into venous channels. These are the backward continuation of the dorsal veins of the penis, which form the commencement of the prostatic plexus. These veins course upwards in the anterior layer of the sheath to the base of the prostate, and then pass backwards around the junction of the prostate and bladder, forming, roughly, a letter Y with a vertical stem and horizontal arms. This is the prostatic plexus, and its relations to the prostate require more careful consideration.

By dissection and microscopic examination (Pl. I, fig. 1, *i*) there is no great difficulty in demonstrating that the veins of the prostatic plexus lie between the layers of the prostatic sheath, and that everywhere they are provided on their prostatic aspect with a layer of this fascia. Moreover, where they course up the anterior aspect of the gland there is in addition a layer of striped muscle-tissue (the muscle of Henle) (Pl. I, fig. 1, *k*) between them and the prostatic capsule proper. It is necessary that the position of these veins should be clearly understood, for it has

[1] 'Handb. d. Eingeweidlehre,' 1866.

important relations to the operation of prostatectomy. The anatomical text-books describe the prostatic plexus as lying between the two layers of the capsule of the prostate.[1] It is evident from the description that the two layers indicated are the layer of recto-vesical fascia and the capsule which immediately surrounds the prostate and is continuous with its stroma, and this is apparently the general view held.

On making sections of the prostate and its surroundings for microscopic examination I was at once struck by the fact that the veins of the prostatic plexus lay between the layers of the sheath of the gland, and that a layer of this fascia separated them from the prostatic capsule proper. The line of separation between the capsule and the sheath is only marked by the difference of structure—the former showing a denser texture, in which unstriped muscle-bundles are abundant, and the latter wavy bundles of fibrous tissue,—and not by the intervention of large veins, as I had been led to expect.

Since making these observations my attention has been drawn by Dr. Robert Proust, of Paris, to the description in his book on perineal prostatectomy published this year.[2] It appears that this observer drew attention to the exact position of these veins and its immense importance in his thesis on perineal prostatectomy[3] in 1900.

The prostatic capsule.—The capsule of the prostate (Pl. I, fig. 1, *l.*) corresponds to the capsule of other glands in the body. It is an integral part of the connective-tissue framework of the gland, being directly continuous with the stroma, and is, indeed, merely the outer margin of this, the layers of which are more or less regularly circular in their disposition. As such, the capsule is inseparable from the organ by dissection. In thickness it varies not only in different glands, but also at different

[1] Quain's 'Anatomy,' vol. iii, pt. iv, p. 249; see also 'Enlargement of the Prostate,' C. W. Mansell Moullin, 2nd ed., p. 7.

[2] 'Prostatectomie périnéale pour hypertrophie,' 1903.

[3] 'Thèse de Paris,' 1900.

parts of the same gland. At some points gland-tubules approach the surface so nearly as to leave only a very narrow margin of tissue, at other parts the gland-tubules lie far back from the surface, and a relatively broad band of fibro-muscular tissue represents the capsule. In front, lying partly in the capsule and partly outside it, are the bundles of striped muscle-tissue above referred to.

The distribution of gland-tissue.—Horizontal sections of the prostate show that the amount of gland-tissue and its relation to the urethra vary at different levels. At the upper limit of the organ gland-tissue is found behind the urethra in small amount, and the bulk of the glandular substance lies on either side. There are no gland-tubules in front of the canal. Thus the glandular substance is arranged in the form of a horseshoe open in front. The median portion behind the urethra corresponds to the position of the middle lobe of Sir Everard Home. Sir Henry Thompson has shown that this middle lobe, if it exists as a separate nodule, is a pathological product; but he does not deny the presence of this layer of prostatic tissue behind the urethra above the ejaculatory ducts. Griffiths demonstrated the openings of the ducts from this median portion on the posterior wall of the urethra above the veru montanum.

A section at the level of the veru montanum (Pl. I, fig. 1) shows the urethra surrounded by glandular tissue except anteriorly. In front of the urethra is a wedge of muscular and fibrous tissue (Pl. I, fig. 1, *n*), which varies in extent in different specimens. In most of my sections the anterior commissure was a well-marked band of tissue without gland-tubules. In a very few the anterior borders of the lateral lobes approached each other closely, and in one specimen they appeared to coalesce.[1]

[1] While Jarjavay ('Recherches anatomiques sur l'urèthre de l'homme,' Paris, 1856) and Thompson ('Diseases of the Prostate,' 1886) held that the portion in front of the urethra was composed entirely of muscular and fibrous tissue, Henle ('Eingeweidlehre,' 1866) and others stated that in 33 per cent. of prostates no anterior commissure was present. In a

Behind the urethra at this level the ejaculatory ducts (Pl. I, fig. 1, *p*) and sinus prostaticus pass backwards and upwards, surrounded by a thick coating of muscular tissue. This band forms a partial separation of the lobes posterior to the urethra, which may be made to appear complete by cutting the prostate obliquely upwards along the line of these ducts. In horizontal sections, however, there is a pretty thick band of glandular tissue behind these ducts and the urethra.

A section at a lower level shows that the anterior fibro-muscular commissure is well marked, and that the posterior band of glandular tissue is rapidly thinning. The lateral lobes are still prominent. At the apex of the prostate no glandular tissue is found at all, the urethra being merely surrounded by muscular and fibrous tissue. It will thus be seen that the greater portion of the glandular tissue is found at the level of the veru montanum and above this, and that there is comparatively little gland-tissue to be found below this level.

The ducts of the prostatic glands open in the prostatic sinuses in the immediate neighbourhood of the veru montanum and on the posterior wall of the urethra above this.

So far as I could ascertain from my specimens, no gland ducts opened into the urethra between the part immediately adjacent to the veru montanum and the membranous urethra. I have not found this definitely stated in the literature on the subject, but from the descriptions and illustrations one is led to infer that such is the case. It is therefore apparent that the connection between the prostate and the urethra at the level of the veru montanum and above this eminence is intimate, but that below this level the two structures merely come into relation with one another.

The prostatic urethra.—Thin slices of the prostate at right angles to the urethra show that at the vesical junction the tube lies at the fore part of the organ, in the same

recent publication ('Krankh. der Prostata,' 1902) Socin and Burckhardt agree with the latter observers.

plane as the anterior borders of the lateral lobes. Lower down, at the level of the veru montanum, the urethra has passed back and lies in the centre of the gland (Pl. I, fig. 1, *o*), the lateral lobes overlapping or even coalescing in front of it. Passing still further downwards, the tube is a little nearer the posterior than the anterior surface, and this position it maintains to the apex of the prostate. The wall of the tube is provided with a thick layer of unstriped muscle, much of which is derived from the internal longitudinal layer of bladder muscle (Thompson). This layer plays an important part in moulding the enlarging prostate. The openings of the ejaculatory ducts and sinus pocularis are situated a little nearer the membranous than the vesical end of the prostatic urethra.

The seminal vesicles.—Before leaving the normal anatomy of the prostate it is necessary to note the position and relation of the seminal vesicles to this organ and to the bladder, for these glands have an important relation to the enlarged prostate. The layer of recto-vesical fascia which encloses the seminal vesicles passes downwards to form the posterior layer of the prostatic sheath. The vesicles lie along the upper border of the posterior aspect of the prostate, but in my dissections, instead of passing almost vertically upwards, they take a transverse direction and only curve upwards at their extremities. They thus form a transverse band lying below the trigone of the bladder. The ureters enter the bladder wall a finger's breadth higher up.

II—Changes in the Prostate and its Surroundings in Enlargement of the Organ.

It is not my intention to enter upon a discussion of the varieties of minute structure or the ultimate pathology of the enlarged prostate. I shall only deal with the changes which immediately concern the operation of prostatectomy.

1. *Changes in the prostatic sheath.*—The weight alone of the larger overgrowths of the prostate must demand

some stronger support than that provided by the normal sheath of pelvic fascia. When we bear in mind also that the increasing calls for micturition and the greater force required for the expulsion of urine must react in some measure upon the attachments of the bladder, it is not unnatural to expect some increase in thickness of the prostatic sheath. Such a change is invariably present. The sheath of the enlarged prostate is a densely woven envelope of fibrous tissue of considerable thickness.

It is difficult to give exact measurements of the increase in thickness at every part and in all cases, but the average proportional increase is certainly not over-stated at three to one. To this must be added a dense matting of the component fibres—whereas the normal sheath was seen to consist of loosely arranged wavy layers of tissue, that of the enlarged prostate is a solid compact layer of interlacing fibres, through which the microtome knife cuts with difficulty.

2. *Changes in the relations of the prostate with its surroundings.*—Mr. Freyer has already insisted upon the "shaking free" of the prostatic mass from its surroundings. This change is more readily appreciated by studying gross specimens than by microscopy. In the normal prostate it is possible, as I have already noted, to strip the sheath away from the gland except at certain points. It is, however, a much more difficult matter to completely enucleate the normal prostate from its surroundings. The points of greatest difficulty in making this attempt are found to be, in the first place, in penetrating the bladder floor in order to reach the prostate. The enlarged prostate forms a larger and more resistant mass, towards which the finger works and against which the bladder base is rent, but this only constitutes a single factor in the preparation for prostatectomy. Other changes which I shall presently describe prepare the way for enucleation in the enlarged organ. Further difficulties are met with in the normal gland at its postero-lateral horns, where the principal vessels and lymphatics enter and leave, at the ejacu-

latory ducts, along the anterior surface, and at the apex of the gland. Apart from these, however, the normal gland is pretty firmly set in its sheath by fibres and vessels passing to and fro between the sheath and capsule, so that it is well nigh impossible, by taking a thick slice of prostate and its surroundings from a fresh body, to shell the prostate from its sheath without some damage to both. Not so in the enlarged prostate. The ease with which the latter shells out from its sheath will be apparent to any observer who makes the attempt.[1]

Another very striking and important change takes place in the relations of the enlarging prostate and its sheath. The upper part of the posterior surface already lies in a corner between the bladder muscle and the lower border of the seminal vesicles. As enlargement of the gland proceeds this wedge begins to insinuate itself between the bladder wall and the vesicles, so that these structures become more and more separated (Pl. I, fig. 2, ii, *l*). The vesicles are pushed further and further back, and are at the same time stripped from the bladder wall until finally they lie behind the upper part of the gland instead of above it. They thus form the upper part of the posterior wall of the sheath. Coincident with this change in relations there is a raising-up of the floor of the bladder composed in this relation of the circular and internal longitudinal coats. In many enlarged prostates, even although their bulk may be considerable, no further change takes place in regard to the upper part of the gland, and these prostates remain extra-vesical. If approached from the bladder they will be found to have raised up the bladder base, but to be covered by the two inner muscular coats. This is a source of difficulty if their removal be attempted. This change in the relations of the upper part of the enlarged prostate and the seminal vesicles may be demonstrated in sagittal sections through the prostate and its surroundings. It will become very evident when the post-mortem specimens of

[1] I refer only to fresh specimens; formaldehyde or alcohol-hardened specimens are useless and misleading.

the prostatic sheath after prostatectomy are examined. This change occurs, I believe, in the majority of cases but not in all. In a post-mortem prostatectomy performed with Mr. Herbert Frankling in January, 1902, a moderately enlarged prostate had pushed upwards and backwards between the rectum and seminal vesicles as high as the recto-vesical pouch of peritoneum. The seminal vesicles remained adherent to the bladder wall. Further, it is apparent in examining some of the specimens of enucleated prostates that the seminal vesicles must have retained their normal relations to the bladder base. This condition is, however, exceptional in my experience, and it appears to depend upon a form of enlargement to which I shall later refer.

As the prostate enlarges an important change takes place in its relation to the bladder wall. Very frequently, but by no means invariably, nodules of the enlarged prostate intrude themselves within the bladder cavity. When examined from the bladder these nodules are found to be covered merely by mucous membrane, which lies directly upon the prostatic capsule. How has this been brought about?

It has been noted that the base of the prostate is covered by a layer of circular bladder muscle, and this again by the inner longitudinal layer of muscle which passes into the urethral wall. In these cases a portion of the upward-growing prostate insinuates itself within the circle of the sphincter vesicæ (Pl. I, fig. 2, iii, *m*). The sphincter becomes more and more widely dilated until, in the prostates which have a considerable intra-vesical bulk, it forms a wide circle, enclosing within its grasp a mass of prostate around which the thumb and forefinger can barely meet. The sphincter thus pressed back does not atrophy as might be expected. Its fibres, partly from being crowded back together, and partaking also, no doubt, in the general muscular hypertrophy which affects the bladder, are more compact and well defined than those of the normal sphincter.

Coincident with this continuous dilatation of the bladder sphincter, there is an upward pressure against the sheet of

longitudinal muscle-fibres which is spread out over the trigone and passes into the urethra. At one point, or at several, the fibres of this layer separate and allow a nodule of prostatic tissue to appear immediately under the bladder mucous membrane (Pl. I, fig. 2, iv, *n*). Should this nodule protrude into the bladder between two strong bands of longitudinal muscle, it is not unlikely that it may become more or less pedunculated. Or several nodules may push between the longitudinal bundles of muscle, and these bundles, crowded together, are to be found in some specimens as strong bands lying in the grooves between the nodules.

In similar manner the well-known middle lobe is formed. It is hardly necessary to state again that a middle lobe does not exist in the normal prostate. The upper surface of the prostate is in the form of a horseshoe around the back and sides of the urethra, and often protrudes into the bladder in this form. Laterally this corresponds to the upper poles of the lateral lobes, and in the middle line posteriorly to that portion under which the ejaculatory ducts tunnel on their way to the urethra. There is, however, no separation of this median posterior portion from the lateral portions.

Why, then, do we so frequently find a median projection of the prostate behind the urethra when the organ enlarges? The reason is not far to seek. The longitudinal muscle of the ureters joins the inner longitudinal layer of bladder muscle as it sweeps over the trigone to merge into the urethral wall. It requires no stretch of imagination to recognise that these two additional bands of muscle are the controlling factor in the production of the middle lobe. An enlargement of the prostate pressing upwards posteriorly will separate these two bands and push in between them, thus forming a projecting button which may, on further growth, become pedunculated from the pressure at its base.

These bands of longitudinal muscle are readily recognised in the prostate after removal. If a specimen which

has been entirely extra-vesical be first examined, a thick sheet of this muscle will be found at the upper end of the specimen, passing into the wall of the urethra. On examining a specimen in which a median lobe projects upwards it will be seen that on either side of this is a strong band of unstriped muscle passing downwards and inwards between the two main lobes. When the intra-vesical enlargement becomes considerable, there are still found nodules, the grooves between which show the remains of bands of this longitudinal layer of the bladder. Not infrequently the upper poles of both lobes project through the vesical orifice, and a bilobed bladder portion is formed. The deep groove between the intra-vesical lobes in these cases is due to a strong band of longitudinal muscle-fibres crowded together in the middle line posteriorly.

The influence of this longitudinal layer of muscle-fibres in moulding the upper part of the enlarged prostate has not, so far as I am aware, been recognised by previous observers.

The study of a large number of cases of enlarged prostate leaves no doubt in my mind as to the importance of this layer not only in regard to the formation of a median lobe, but also in regard to the ease or difficulty with which the operation of prostatectomy can be performed.

One word more in regard to the middle lobe. Mr. Freyer has pointed out that in his specimens this lobe is usually an offshoot from one of the lateral lobes, and this is borne out by further study of his enucleated prostates. The fact must, however, be borne in mind that the "median portion," as French writers call this part in the normal prostate, is continuous with the lateral lobes, and its enlargement may be coincident with that of one or other lateral lobe, and in such a case it must be a difficult matter to say what is median and what is lateral lobe spread medianwards. Apart from this, however, I have seen cases, and I do not think they are altogether uncommon, in which, with a minimal enlargement of the lateral

lobes, a nodule projected from the middle line posteriorly at the upper end of the prostatic urethra.

One fact is brought into special prominence by a study of these specimens of enucleated prostate and of the post-mortem specimens in which the prostate has been removed. The enlargement of the gland appears, in the majority of cases, to be confined to the portion lying above the level of the ejaculatory ducts and the veru montanum. This is most readily appreciated on examination of the specimens from which the prostate has been removed. In these it is found that the increased capacity required for the enlarged prostate is obtained almost entirely at the expense of the structures abutting upon the upper portion of the gland, and that little or no change has occurred at the lower part. The veru montanum and ejaculatory ducts remain fixed.

It is usually stated that the upper median portion of the gland shows a special tendency to enlarge, but this appears to me to fall short of the whole truth. It is the entire upper portion of the gland which shows this tendency, not only the median portion of it. There are, however, a few prostates in which the glandular substance below the ejaculatory ducts and behind the urethra is the seat of marked enlargement. In such cases the ejaculatory ducts and seminal vesicles retain their normal relations to the bladder wall and to the prostate as a whole.

3. *Changes in the prostatic urethra.*—The changes in the urethral form, length, and calibre are perhaps the most varying factors in the structural alterations which take place in enlargement of the prostate.

The junction of the bladder mucous membrane with that of the prostatic urethra can be distinguished without difficulty on opening the urethra in most cases of enlarged prostate.

As the enlarging prostate begins to project through the lumen of the vesical sphincter it drags up the urethral mucous membrane with it into the bladder. We thus find that the intra-vesical projections from the prostate are

covered, in part at least, by the mucous membrane derived from the prostatic urethra. In very large intra-vesical growths it is of course impossible to recognise urethral from vesical mucous membrane in the thinned mucous covering of the nodules, but in smaller ingrowths and in the collar-like enlargements there is no difficulty in observing the line of junction, which is usually placed on the vesical aspect of the nodule or rim, and not on its urethral aspect. It appears possible that in this observation may be found the explanation of the frequency of micturition which is such a constant and distressing symptom in cases of enlarged prostate.

The elongation and varieties of change in contour of the prostatic urethra in the enlarged prostate are too well known to dwell upon here. One point I wish, however, to insist upon is that the elongation affects that portion of the urethra lying between the bladder and the veru montanum, and hardly at all the part in front of this. This goes with what has already been said in regard to the portion of prostate usually enlarged, and does not therefore require further discussion.

The change in the shape of the urethra into an antero-posterior slit is well known, but there is a very marked change in the relation of the urethra to the prostate as a whole which has not yet, so far as I am aware, been pointed out. This change consists in a backward sinking of the posterior wall of the urethra between the lobes. If a transverse section of a normal prostate be examined, it will be found that at the level of the veru montanum there is a considerable mass of gland-tissue behind it. The position of the tube has been given as about midway between the anterior and posterior surfaces. In a similar section of an enlarged prostate it is found that the urethra has passed backwards between the two lobes and now occupies a position at the posterior surface between the lobes, and with little or in many cases no gland-tissue behind it. This is even more apparent at the lower part of the prostatic urethra than at the upper, but applies

only to the extra-vesical part of the enlarged prostates. This is most marked at the level of the veru montanum. The means by which this change in position is brought about are not at first obvious.

The antero-posterior elongation of the lobes, which is one of the earliest and most constant changes, must drag upon the ducts of the prostatic glands, opening as they do almost entirely in the grooves on each side of the montanal ridge on the posterior wall. But even if we add to this a certain amount of outward rotation of the posterior end of each lobe, which I am inclined to believe takes place, these factors do not seem sufficient to displace the posterior wall backwards to such a marked degree. The structure which appears to me to play the most important part in causing this change is the fibrous and muscular band which surrounds and strengthens the ejaculatory ducts. This band finds attachment at the veru montanum at one end and at the seminal vesicles at the other. It has already been noted that the seminal vesicles are stripped from the bladder wall and forced backwards by the enlarging lobes. This must exercise a continuous backward drag on the posterior wall of the urethra, and tend to tear it from between the prostatic lobes. I consider, therefore, that this band of tissue exerts a very important influence upon the change of position of the urethra and on its distortion.

The muscular wall of the urethra appears to be thinner in the enlarged prostate than in the normal gland. This no doubt results from the longitudinal and antero-posterior stretching of the tube, which results from the increased bulk of the prostate. The epithelium of the mucous membrane also is thinned out so that in many specimens it is represented merely by one or two layers of low cubical cells.

4. *The prostatic capsule proper.*—The margin of connective tissue which surrounds the prostate and forms its proper capsule is a distinct structure even in the normal condition, and can be traced by the unaided eye surrounding the entire organ. In the enlarged prostate

this layer becomes more definite, and its fibres more circular in their arrangement. It is everywhere thickened, and more especially so over the anterior aspect of the gland. In prostates which bulge into the bladder there is often a strong band of thickening at the part corresponding to the upper limit of the normal prostate, and it is remarkable that that part of the capsule above the ejaculatory ducts is almost invariably much thicker than that at a lower level. I am inclined to believe, from the examination of certain of the specimens of enucleated prostates, that part, at least, of the thick mass of capsule is derived from the hypertrophy of the bladder muscle, which is continued downwards into the prostatic capsule. The thick capsule consists almost entirely of plain muscle-fibres. The fibres are very long and circularly arranged around the entire gland, and their nuclei are long and distinct. This regular circular arrangement, together with the general increase in thickness of the capsule, are the chief features of difference from the normal capsule. Here and there a blood-vessel is found, and the wall of these vessels is thickened and shows hyaline degeneration.

It is occasionally possible in examining a number of sections to find in one or two a flattened gland-tubule or a group of these lying amongst the fibres of the capsule. In the normal gland the capsule and stroma are continuous, and the gland-tubules approach the surface at some parts. It is therefore not surprising that in the general thickening of stroma and capsule some of the gland-follicles may get wedged into the capsule of the enlarged prostate. This is, however, exceptional, and the most striking feature in the capsule of the enlarged prostate is its increased thickness and distinctness and the homogeneous composition of its component tissues.

It has not been my fortune to meet with layers of compressed prostatic gland-tissue disposed in circular manner around the enlarged organ, such as have recently been described.[1]

[1] C. S. Wallace, 'Lancet,' Dec. 5th, 1903, p. 1578.

Not only does the thickening of the proper capsule more clearly define the limits of the whole gland, but the lobes of the enlarged prostate become more distinctly outlined. This is best appreciated in examining transverse sections of enlarged prostates. Each lobe acquires for itself a more or less distinct capsule, which surrounds it, and the two lobes open out from each other posteriorly, and allow of the backward sinking of the urethra. Further, the anterior commissure becomes more definite, thicker, and denser, and appears more readily to split away from one or other lateral lobe, adhering to the anterior border of the other.

III.—The Parts left behind after the Operation of Prostatectomy.

The material collected for this part of the investigation consists of four specimens:—

I. A post-mortem specimen from a case of prostatectomy performed by Mr. Swinford Edwards. Death occurred nine hours after the operation.

II. A specimen from a case of prostatectomy by Mr. Freyer. Death ten days after the operation.

III. A specimen sent by a provincial surgeon.

IV. A specimen from a case operated upon by myself at St. Peter's Hospital. Death fifteen hours after the operation.

Specimens I, II, and IV were removed from the bodies in the following manner. The bladder and rectum were first detached, together with the levatores ani, by cutting as close as possible to the pelvic wall. A median incision was then made in the perinæum over the bulb and carried back around the anus. The bulb, the perineal muscles, the triangular fascia, and the anus were then dissected from the pelvic outlet, and the whole mass drawn up through the abdominal wound. The bladder and the prostatic sheath were then split along the middle line anteriorly.

In Specimens III and IV the presence of a nodule of

carcinoma outside the sheath in the former and of lymphatic pelvic glands, the seat of malignant growth, in the latter, showed that prostatectomy had been performed on carcinomatous prostates. These specimens might therefore be put aside were it not that, notwithstanding the undoubted malignant nature of the prostates removed, they bear out the facts to be described as relating to Specimens I and II. And further, it has been possible by the dissection of these specimens to define the gross anatomy of the parts left behind with less mutilation to Specimens I and II than would otherwise have been possible.

I shall describe Specimen No. 1 (Pl. II, fig. 3), adding to the description the points of similarity or difference exhibited by the other specimens.

At the upper part is the trabeculated bladder (Pl. II, fig. 3, *a*), and below this the cavity left behind after removal of the prostate (Pl. II, fig. 3, *d*). The wall of the bladder is hypertrophied, and the outer and inner longitudinal layers of muscle are readily traced. The vesical sphincter (Pl. II, fig. 3, *c*) is a large, well-defined, muscular band, and can be seen to surround an aperture of considerable diameter. This aperture is notable, as it represents the calibre of the opening through which the intra-vesical portion of the prostate entered the bladder, and if the prostate from this case be examined it will be found that a groove marks the junction of the intra- and extra-vesical portions. This groove is produced by the pressure of the muscle just described.

In relation to the prostatic cavity it is necessary to examine—

1. The remains of the urethra;
2. The walls of the cavity.

1. *The remains of the urethra.*—From the apex of the trigone of the bladder a tongue of tissue hangs downwards for six-eighths of an inch, and the lower end of this comes in contact with another process of tissue slightly shorter, which projects upwards into the cavity from the

centre of its floor (Pl. II, fig. 3, *e e*). This latter process has a median longitudinal ridge. These processes prove on examination to be the remains of the prostatic urethra. And, allowing for a very slight amount of contraction on the tube being severed, there is no question that they represent the whole length of the prostatic urethra in this case. When the specimen was removed from the body the urethra was in this severed condition, and the urethral wall was without doubt torn across at the time of operation.

In the second specimen (II) the vesical end of the urethra has been torn across at its junction with the vesical mucous membrane. The lower portion of the urethra, three-quarters of an inch in length, has been left behind, and is bound down to the floor and posterior wall of the cavity. A portion of the urethra, comprising that part between the veru montanum and the bladder, has therefore been removed with the prostate.

In Specimen III a portion of the mucous membrane of the trigone has been removed, and is found adhering to the upper part of the prostate.[1] The mucous membrane of the urethra is severed at the membranous portion. The entire urethra has therefore been removed. In Specimen IV the urethra was removed at the operation by tearing through the mucous membrane at its vesical end and at the junction with the membranous urethra.

2. *The walls of the cavity from which the prostate has been removed.*—The space from which the prostate has been removed in Specimen I is a single cavity with an incomplete roof, a flattened posterior wall and rounded anterior and lateral walls which pass into each other. Indications of the bilobed form of the prostate which occupied the space can be seen, especially at the upper part of the cavity. The posterior part of the cavity is partly roofed over by an overhanging ledge, which is formed by the muscular wall of the bladder and the mucous membrane of the trigone. From the centre of

[1] It will be remembered that this specimen was malignant.

this ledge hangs the portion of urethra already described. The lining of the cavity is comparatively smooth. Around the upper part there is a circular arrangement of fibres, continuous with the under-surface of the circular fibres of the sphincter. Around the entrance of the urethra at the lower part there is also an arrangement of fibres in circular manner. Between these sets of circular fibres the wall is smooth. Springing from the posterior wall in the median line, rather nearer the floor than the roof, is a tuft of tissue rather more than a quarter of an inch long (Pl. II, fig. 3, *f*). This projects forwards into the cavity and almost meets the upper extremity of the lower urethral segment. This is formed by the ejaculatory ducts and the surrounding connective tissue. The upper end of the portion of urethra left behind in Specimen II corresponds to the position of the veru montanum.

In Specimens III and IV no trace of the ejaculatory ducts could be found.

On dissection of the posterior wall (in Specimens II, III, and IV, and partial dissection in Specimen I) it is found that the upper part, including rather more than the upper half, is formed by the seminal vesicles and the lower ends of the vasa deferentia. They are enclosed within the layer of recto-vesical fascia, and this fascia, continued downwards below the vesicles, forms the lower part of the posterior wall and the floor. From within the cavity, however, it is necessary to turn down a thin layer of muscular tissue before reaching the anterior surface of the upper part of the vesicles. This layer thins off rapidly as it passes down and does not reach the middle of the cavity. It is present at the upper part of the lateral wall, and is also found anteriorly. The circular arrangement of these fibres has already been seen in Specimen I. At the cut edge of the specimen (*i. e.* in the middle line anteriorly) these fibres are seen, and may be traced upwards to the middle layer of bladder muscle with the unaided eye. On microscopic section (Pl. II, fig. 4, *k*) the continuity of these fibres with the middle layer of bladder

muscle, their muscular structure, and their extent are corroborated.

It is to be noted that the peritoneal sac (pouch of Douglas) maintains its normal relation to the seminal vesicles, and thus comes to be a posterior relation of the extra-vesical portion of the enlarged prostate. The lateral walls of the cavity are thinner than the anterior and posterior walls. Here the surface exposed is smooth and is formed by the prostatic sheath—that is to say, the downward prolongation of the visceral layer of pelvic fascia over the side of the prostate. Outside this is the levator ani muscle (Pl. II, fig. 3, *l*). The anterior wall, which passes imperceptibly into the lateral walls, consists of the anterior part of the prostatic sheath. This has been already described as being formed by a strong band of fibrous tissue passing between the two lateral layers in front of the prostate. Lining the upper part of this wall are the circular muscular fibres, continuous with the middle bladder layer of muscle, which have been already described.

Between the layers of fibrous tissue which form this part of the sheath the large veins of the prostatic plexus pass upwards (Pl. II, fig. 3, *h*). With the unaided eye it is readily recognised that these veins are protected on the side of the cavity by a strong layer of fascia (Pl. II, fig. 3, *i*). This will be further referred to in describing a microscopic section of the sheath. On the floor of the cavity around the point of entrance of the urethra circularly arranged fibres are found (Pl. II, fig. 3, *k*). These circular fibres may be traced outwards from the urethra over a small area of the floor. On microscopic section they are found to consist of striped muscle-fibres loosely arranged, and they may be traced to the urethra and pass alongside its wall through the incomplete apex of the sheath to become continuous with the constrictor urethræ muscle. This is the remains of the voluntary muscle which has already been described as surrounding the apex of the gland and continuous with the constrictor urethræ. The vertical portion of this muscle, which was shown to lie between the prostate and

its sheath anteriorly, is not represented in the sheath after the enlarged prostate has been removed. It will later be found adhering to a specimen of enucleated prostate.

I shall now describe very briefly a microscopic section of the entire wall of the capsule from bladder wall to urethra (Pl. II, fig. 4). This is a sagittal section taken from the anterior wall of Specimen I.

At the upper part the bladder wall is seen (Pl. II, fig. 4, *a*) and the different layers are readily distinguished. Passing down from this is a sheath of fascia (Pl. II, fig. 4, *e*) which is built up of densely packed fibres arranged for the most part in a vertical direction. Several large veins of the prostatic plexus (Pl. II, fig. 4, *f*) are seen passing up between the layers, and it is to be noted that they are protected on their inner side by a strong layer of fascia. At the lower part of the section the continuation upwards of the constrictor urethræ alongside the urethra may be seen (Pl. II, fig. 4, *h*), and the manner in which this striped muscle insinuates itself within the sheath and then spreads out for a short distance on its inner aspect is readily appreciated.

The inner layers of the section should now be studied in order to ascertain what structures line the cavity. At the upper part the circular muscle of the bladder is continued down on the inside of the sheath in a thin layer, which tails off and disappears about half-way down (Pl. II, fig. 4, *k*). At the lower part the striped muscle just described passes up for a short distance. Between these two muscular layers the bare sheath is exposed.

At one point there is a small nodule of prostatic tissue the size of a pin's head adhering to the wall (Pl. II, fig. 4, *l*). The structure and relations of this nodule deserve careful consideration. The prostatic tissue consists of a single oval nodule surrounded by its own special capsule. The gland alveoli are oval, round, or irregular, and show the usual epithelium and intra-acinous projections. The alveoli are not flattened or atrophied. Outside the capsule of the nodule is a well-marked layer of tissue, which is evidently a portion of the proper capsule of the prostate. Between

this capsule and the sheath there is a well-marked line of cleavage.

This nodule has been torn away from the surface of the prostate during the operation and left adhering to the wall of the sheath. It is particularly worthy of note that there is no layer of compressed gland-tissue between this and the sheath, but that the nodule is separated from the sheath only by a portion of the prostatic capsule. The significance of these facts will come up for discussion later.

Sections of the lateral wall corroborate the facts already stated in the description of the specimens. The veins of the prostatic plexus are of course not represented.

IV.—The Structures removed at the Operation of Prostatectomy.

The material for this portion of the subject consists of seventy-three prostates removed by Mr. P. J. Freyer. Of these, eleven were presented by Mr. Freyer to the Royal College of Surgeons Museum, and have been kindly lent by the conservator for the purpose of this demonstration.

The prostates vary in size and weight within very wide limits. The largest weighs 10¼ ounces and the smallest but ¾ of an ounce, while the average weight is a little over 3½ ounces. I have made sections of two of these prostates, and Mr. Freyer has further very kindly permitted me to excise such portions of other specimens, the significance of which was not clear without microscopic examination. The latter I was fortunately able to carry out without interfering with the general contour of the specimens.

I have classified these prostates in two groups, on anatomical and on operative grounds. These groups will be seen to have little relation to the size of the prostates or to the effect of operative manipulation upon them. In one group I have placed those prostates which have, previous to the operation, been entirely contained within the prostatic

sheath, and which did not therefore possess an intra-vesical portion. The other group consists of those prostates which were partly contained within the prostatic sheath, but which had so far intruded their bulk within the vesical cavity that they consisted of two distinct portions, an intra- and an extra-vesical. Such a division might at first sight appear to be entirely clinical, or at least not to apply to the prostates after removal. This is not so. For it is no difficult matter, in studying the morbid specimens, to set aside those prostates which possessed an intra-vesical portion from those which did not. The relative size of the prostates does not coincide with these divisions so closely as one would expect on theoretical grounds. Among the specimens which were totally excluded from the bladder are prostates weighing $2\frac{3}{4}$ ounces, while among those which possessed an intra-vesical portion specimens weighing as little as $\frac{3}{4}$ of an ounce are found. This bears out the clinical observation that a prostate which *per rectum* feels small or only slightly enlarged may still protrude into the bladder and produce the baleful effects of a greatly enlarged organ. From the point of view of the operator this classification is certainly justified, for upon the presence or absence of an intra-vesical portion depends the ease or difficulty with which the first part of the enucleation is carried out.

1. *Prostates which protrude into the bladder cavity.*— A typical example of an enucleated prostate which has protruded into the bladder will first be considered (Pl. III, fig. 5) and the points of similarity and difference between this specimen and others of the same class then pointed out.

The intra- and extra-vesical portions are readily distinguished. At the junction of these two parts a deep groove (Pl. III, fig. 5, *e*) exists, and I have already pointed out that this results from the pressure of the hypertrophied sphincter of the bladder.

The portion which has been contained within the prostatic sheath (Pl. III, fig. 5, *a*, *b*) demands first consideration, for in most points the description of this covers also the charac-

ters of the second class, the entire bulk of which was extra-vesical. The two lobes are distinguished without difficulty from the front and from the back of the specimen. These lobes are wrapped around by a coating of circular bundles of tissue. This coat is complete except at one point, where a small transverse tear has exposed a subjacent nodule of prostatic tissue. The circular bundles in this specimen are of comparatively fine texture, and the general surface is smooth and regular.

At the lower end of the specimen—that is, the part which abutted on the triangular ligament—the lower pole of each lobe is indicated, and between these is the opening of the lower end of the prostatic urethra. The fibres of the capsule dip in here and pass up along the wall of this canal. This is most marked in the anterior surface. Posteriorly the capsule uniting the lobes passes down to their extreme limit. At the upper part of the extra-vesical portion of the specimen there is a well-marked thickening of this capsule, which is most apparent in the deep groove on the right side of the specimen.

In the middle line anteriorly is a vertical strand of fibres which have been torn across (Pl. III, fig. 5, *d*). These fibres, which extend for about three-quarters of an inch between the two lobes, have evidently formed a band of adhesion with the tissues that have been left behind.

The intra-vesical portion of the specimen is marked off from the rest by a deep groove on the right side. This groove passes round the entire circumference, but is shallow posteriorly and on the left side. This portion surrounds the opening of the urethra behind and on each side, only a small amount of prostatic tissue appearing in front of the opening.

In the middle line posteriorly is a large rounded nodule representing a middle lobe (Pl. III, fig. 5, *f*), and this is separated from the lateral portions by grooves in which bands of tissue can be traced downwards into the wall of the urethral tunnel. These bands of tissue have evidently been torn across at their upper ends. The appearance

presented is that of a median and two lateral intra-vesical lobes, the right lateral lobe being undermined by the deep circular groove already mentioned. The capsule which surrounds the extra-vesical portion is continued up over the intra-vesical lobes, but is here much thinner. This thinning is most marked over the middle and right lobes.

The ejaculatory ducts could not be detected on the posterior surface of the specimen.

A section at right angles to the urethra at about the middle of the extra-vesical portion shows two well-marked lobes. A compact capsule surrounds the whole and is thicker in front than at the sides. In the middle line behind, the capsule, after sending some fibres across from lobe to lobe, dips inwards between the lobes and joins a more or less well-marked capsule which surrounds each lobe. The urethra is situated between the two lobes, with only a small wedge of tissue separating it from the posterior surface. In this wedge no gland-tissue is apparent to the naked eye. Each lobe consists of numerous nodules of adenomatous prostatic tissue.

A section at the level of the deep circular groove shows that the right lobe is not represented, but the left lobe forms a large mass of adenomatous tissue on the left side of the urethra. The urethra itself is displaced forwards and to the right. The capsule is here represented by a much thicker band of circular fibres, which, on the right of the urethra, over the position of the upper pole of the right lobe, forms a broad, dense mass of tissue.

A section through the intra-vesical portion shows that the urethra is still further forward, and that it is surrounded on each side and behind by a continuous collar of adenomatous tissue, the largest mass being to the left side and representing the upward continuation of the left lobe. The gland-tissue is, as elsewhere, completely surrounded by a firm capsule.

It is therefore evident that the right lobe in this specimen is wholly extra-vesical, and that the intra-

vesical portion is formed by the upward continuation of the left lobe, which has become bent round the opening of the urethral canal in the form of a horseshoe. Microscopic sections of the bands of tissue which pass down the grooves on each side of the apparent middle lobe show that they consist of plain muscle-fibre, and this is corroborated by sections from similar bands in other specimens. These bands have already been shown to pass into the wall of the urethra, and have been traced to the inner layer of bladder muscle. The importance of these bands in moulding the intra-vesical enlargement of the prostate has also been discussed.

A microscopic section through the entire mass at a level just above the middle of the extra-vesical portion (Pl. IV, fig. 6) shows the following points of interest:—The two lobes are well defined, the left being larger and more distinctly outlined than the right.

The whole mass is surrounded by a capsule, which is of great thickness in front but thinner laterally and behind (Pl. IV, fig. 6, *g*). Each lobe is subdivided into numerous lobules by rings of fibrous tissue, and these lobules show the usual cystic adenomatous formation found in enlarged prostates. A band of fibres leaves the capsule anteriorly and dips in on each side between the anterior borders of the lobes, passing backwards on each side of the urethra to join the capsule again posteriorly. This is most marked on the left lobe, and gives the appearance of a special capsule to each lobe. Between the lobes anteriorly is a mass of unstriped muscle and fibrous tissue. This represents the anterior commissure (Pl. IV, fig. 6, *h*). It shows an isolated nodule of gland-tissue embedded in its substance. From the urethra a line of cleavage passes forwards, but does not reach the surface (Pl. IV, fig. 6, *k*). It is apparent that a slightly greater degree of force at the time of the operation would have burst the two lobes asunder in front, leaving the anterior commissure attached to the right lobe. The urethra (Pl. IV, fig. 6, *a*) is elongated antero-posteriorly, and is displaced some distance to the right of the middle

line, owing to the greater bulk of the left lobe. A more striking change in position of the urethra is, however, the sinking backward between the lobes. The urethra lies between the lobes at the posterior surface of the prostate with no gland-tissue behind it.

If a line be drawn through each lobe in its longest antero-posterior diameter and compared with lines drawn in a similar manner through the lobes of the normal prostate at the same level, it will be seen that there is a certain degree of outward rotation of the hinder part of each lobe. The importance of this rotation has already been discussed.

If the capsule be examined more minutely, it will be found that it is composed of circular layers of densely packed, unstriped muscular fibre. The fibres are long and their characteristic nuclei well stained and distinct. Here and there a blood-vessel is found with sometimes some perivascular round-celled infiltration, and some of these vessels show hyaline changes in their walls.

In a few sections it is possible to find at some part of the circumference an isolated flattened gland-tubule, or a group of these, lying among the layers of the capsule. This is exceptional, however, and the capsule is formed for the most part of dense layers of unstriped muscle which clearly correspond to the capsule of the normal gland.

At one part on the posterior surface of the right lobe the capsule has been torn open and the subjacent lobule of gland-tissue exposed (Pl. IV, fig. 6, *l*). There is, however, no loss of substance such as will be shown to have occurred in a few of the specimens, and it is probable that the tearing of the capsule has resulted from the firm grasp of the forceps necessary to deliver the enucleated prostate from the bladder through the supra-pubic wound.

Attached to the front of the capsule, slightly to the left of the middle line, is a tuft of striped muscle-tissue. This corresponds to the vertical band of torn fibres seen on

examining the anterior surface of the specimen. It represents the continuation upwards of the striped muscle of Henle between the sheath and capsule of the prostate, and is an important landmark in defining the line of enucleation.

The muscular wall of the urethra is relatively thin as compared with that of the normal organ. The layers of which it is composed are, however, more distinctly defined from the stroma of the gland. The epithelium lining the tube in this specimen has not suffered from the elongation of the urethra which has taken place. In other specimens, however, the epithelium is thinned out, and in some parts is merely represented by a single layer of cubical cells.

The veru montanum is represented in this section (Pl. IV, fig. 6, *b*) unchanged in appearance and structure, and the ejaculatory ducts are seen passing backwards, having been torn across a short distance from the urethra. The whole length of the prostatic urethra is represented in this specimen.

While the specimen just described is typical of the group of prostates which have protruded into the bladder, the size and form of the various members of this group varies within wide limits. Many of these prostates are extra-vesical, with the exception of a single small nodule projecting through the sphincteric ring. In others the intra-vesical equals and closely resembles the extra-vesical portion, being only defined from it by the deep circular groove of the sphincter; or, again, the intra-vesical portion may greatly exceed in size that portion outside the bladder.

The form which the intra-vesical portion takes shows an almost endless variety.

The following figures relate to fifty-four specimens examined with a view to determining the origin of the intra-vesical projection.

It is to be remembered that these figures apply to the specimens examined after removal and not to the cystoscopic appearances during life.

Median lobe alone . . .	9
Median and lateral lobes—	
Three lobes distinct . .	2
Fused collar. . . .	12
Median and left . . .	2
Median and right. . .	2
Lateral lobes, both . . .	15
„ „ left only . .	9
„ „ right only . .	3
	54

In the smallest specimens the only cause for prostatic symptoms appeared to be the extension upwards through the vesical sphincter of a collar of prostatic tissue or of nodules from the median portion. The median projection, when arising from the median portion of the prostate, was in most instances small. The larger outgrowths from this portion were either pedunculated or fused with intra-vesical lateral lobes. There were three very remarkable specimens in which the left lobe projected alone into the bladder and formed a collar-like mass around the urethral opening. In two of these this intra-vesical portion resembled a sickle, and in the third the appearance of a middle and two lateral lobes was presented.

In one case the intra-vesical nodule had evidently burst through the floor of the trigone instead of passing through the lumen of the sphincter, for here a distict band of circular muscle-fibres was found behind the urethral opening and in front of the intra-vesical nodule.

2. *Enlarged prostates which are extra-vesical.*—These form a smaller group than the previous one. The description of the extra-vesical portion of the prostate already given applies in all respects to this group. There is of course no deep circular groove, as the prostate has not projected through the ring of the sphincter. The upper poles of the lobes are covered by the capsule, and at the junction of the urethral wall with the bladder, especially on its posterior aspect, the longitudinal fibres of the

bladder which join the urethral wall are found torn across.

It is now necessary to examine certain points which may apply to specimens in either of these groups. In a few specimens it is evident that something more than merely the capsule has been removed with the prostate. In one specimen the torn edge of the mucous membrane and muscle of part of the trigone is seen, adhering to upper part of the specimen. In other specimens which have had an intra-vesical collar or nodule there may be observed adhering to the posterior or under-surface of this numerous transverse fibres, which evidently have been torn from the floor of the bladder immediately adjacent to the vesical outlet. When these fibres are traced downwards they are found to pass into the circular layers of the capsule, and some of them split off and pass round each side of the intra-vesical nodule into the wall of the urethra. It would therefore appear that there is not only a continuation of the muscular fibres of the bladder into the urethral wall, but that there is also a contribution of these fibres to the capsule of the prostate. This may in part explain the varying thickness of the capsule in different specimens.

In many specimens the capsule and the anterior commissure have given way and allowed the two lobes to separate anteriorly (Pl. III, fig. 7). The line of cleavage in such a case has already been indicated in describing a section through an unopened prostate.

These open specimens do not differ from the closed variety except in the rupture of the anterior commissure; they include examples of both the intra- and the extra-vesical groups just described. They form the majority of the specimens. In fifty-nine enucleated prostates fifty-one were open anteriorly and only eight closed. In the closed prostates the capsule forms a thicker and stronger envelope that in the majority of the open variety, and to this no doubt the unbroken condition of the anterior commissure is due. The strongest part of the capsule is

undoubtedly the upper part—that part which surrounds the lobes above the level of the ejaculatory ducts. In some specimens the thickness of this part of the capsule is very striking. This is due, I believe, to the addition of muscular fibres from the wall of the bladder.

In some of the specimens, such as that described in detail, the capsule uniting the two lobes was continued down to their lower poles posteriorly, and in a few of these a prominent adenomatous nodule was found in the middle line posteriorly. The ejaculatory ducts were torn across just above the nodule, which therefore represented an enlargement of the portion of prostatic tissue in the middle line immediately below these ducts. This condition was found in only three of the specimens. In many of the specimens the lower poles of the lateral lobes projected some distance beyond the capsule, which surrounded the whole mass. On examination it was found that the capsule at this part posteriorly was torn open (Pl. III, fig. 7, *f*).

It was evident in a few specimens that portions of the capsule on the surface of the lobes were wanting; the adenomatous nodules of the prostate were exposed at these parts, and probably a nodule had been torn off at the time of the operation and left behind.

It would be impossible, without submitting each specimen to section and microscopic examination, to state precisely in all cases whether the whole, or a part, or none at all of the urethra was removed with the prostate. I have been able, however, by a comparison of the prostates of which I have made sections with others presenting similar appearances, and by excising portions from open or from closed prostates, and, lastly, by comparison with the post-mortem specimens already described, to come to some definite conclusions in regard to the presence or absence of the urethra in the enucleated prostates.[1]

[1] These conclusions were formulated without reference to Mr. Freyer's statements as to leaving the urethra behind. After making notes on the specimens I compared them with the statements made in regard to the operation, and in most of the cases in which I was able to give a

In the first place, the entire urethra is removed in certain cases. This has been shown to be the case in the large closed specimen which was cut at different levels. The prostates in which this occurs are nearly all of the closed variety; that is, with the prostatic ring unbroken. Further, it has been seen in two of the post-mortem specimens that the entire prostatic urethra is wanting.

It would of course be impossible to remove the completely closed prostate, which is in the form of a ring surrounding the urethral tube, without tearing across the urethra at some part. The usual condition in these closed prostates is that the whole prostatic urethra remains in the prostate and is removed with it. It is interesting, however, to note that the urethral wall proved so resistent in one such case that it was deliberately torn across at the bladder end, and the prostate was slipped over it, leaving it behind, attached at the distal end.[1]

Secondly, the whole urethra may be left behind. In these cases the prostate is almost invariably of the open type. In the case just quoted, however, the specimen was of the closed variety. The muscular wall of the urethra is also left behind in these cases, not merely the tube of mucous membrane. The lobes in some cases have been separated along both commissures during removal, but in the majority they remain adherent posteriorly, the hinge by which they are connected being composed of fibro-muscular tissue, with or without the presence of a layer of prostatic tissue.

What the condition of the urethra which is wholly left behind at the operation may be I have only the evidence of one post-mortem examination to show. In this specimen the urethra was torn across about the level of the veru montanum, and the upper and lower segments were left projecting into the cavity. I see no reason to doubt, as one observer has, after the examination of a

definite opinion it tallied with the clinical description. In a few cases there were points of difference.

[1] Case xvi, 'Brit. Med. Journ.,' Nov. 8th, 1902.

few specimens, Mr. Freyer's statement that in some of the cases the urethra was left intact and the lobes of prostate stripped from it and removed through the opening in the bladder base, or that in one case the upper end of the urethra was torn across at its vesical end and the prostatic ring drawn from off the tube. Such conditions are quite compatible with my observations on the morbid specimens, and I am prepared to accept them as important evidence in regard to the condition of the urethra which is left behind. Whether this intact urethra or the severed portions of the urethra are to be of permanent service to the individual is quite another question. My own impression is that when a living tube of this length is isolated and remains merely attached at each end, the lack of blood-supply will lead to sloughing, at all events of the central part. It may be said, of course, that the walls of the cavity close around it, and the nutrition of the tube is maintained by a collateral circulation through adhesions. An examination of the fascial lining of the cavity does not, however, support the idea that rapid adhesions will take place, and the manipulations during the operation, added to the septicity, which is seldom absent from such bladders, are more than likely to forestall any adhesions by causing the death of the tube.

There is a third urethral condition shown by these specimens. Part of the urethra may be removed and part left behind.

If one of the open variety of prostates be examined (Pl. III, fig. 7), it may be found that the flat inner surface of each lobe for a considerable area is smooth and glistening (Pl. III, fig. 7, *a*, *b*), and that the lobes are united by a hinge of tissue, which binds them together at the upper half of their postero-internal borders (Pl. III, fig. 7, *c*). The anterior surface of this hinge shows a median vertical ridge with smaller ridges converging towards a point at its lower extremity. The appearance is that presented by the montanal ridge and the point at the lower extremity, the veru montanum partly torn away (Pl. III, fig. 7, *d*).

Sections of the glistening lining of the median surface of the lobes show that it is urethral mucous membrane thinned out so that the epithelium in parts is represented merely by a row of cubical cells. By excising the hinge of tissue between the lobes and cutting transverse sections at different levels it is found to consist of a few small nodules of prostatic tissue and the posterior muscular wall of the urethra, with the remains of the mucous membrane; no trace of the ejaculatory ducts can be found in any of the sections. The median ridge is simply a muscular eminence covered with urethral mucosa. It would therefore appear that this represents the portion of the urethra between the bladder and the veru montanum, and that the segment below this had been left behind. Further evidence in support of this view is, however, available. In a case in which the enucleated prostate was similar to that just described the post-mortem specimen showed that the lower part of the urethra had been left *in situ*, while the portion from the veru montanum upwards had been removed.

An examination of many of the enucleated specimens shows that a similar condition is present. The median posterior commissure extends downwards only as far as the level of the veru montanum and there ceases; below this level there is evidence of its having been torn across, and the lower parts of the lobes are separate, the urethra at this part being wanting. In some of the specimens the torn stump of the ejaculatory ducts and an appearance resembling the veru montanum at the lower limit of the posterior hinge mark accurately the level at which the urethra had been torn across. It seems probable from the large proportion of these specimens that this is what usually happens.

It has already been stated that the upper part of the prostatic urethra is intimately connected with the prostate by the prostatic ducts, but that the lower part of the gland merely lies in relation to the tube. This is borne out in a very striking manner by these observations.

The torn ejaculatory ducts are apparent in a number of

the specimens, and are found in two situations—either low down below the middle of the extra-vesical portion of the specimens or quite at the upper limit of this part. From the position of these ducts the situation of the lower border of the seminal vesicles in the parts left behind may be inferred with tolerable accuracy.

In No. 10 of Mr. Freyer's series[1] the torn ends of these ducts are seen at the upper part of the specimen on its posterior surface, and it may be assumed that here the seminal vesicles retained their normal relation to the prostate even after enlargement. In the majority of cases in which those ducts can be seen, however, they are situated low down, and, by applying the knowledge already gained from post-mortem specimens to this fact, we may judge that the seminal vesicles in most cases are applied to the back of the prostate to form the upper part of the sheath.

V. Observations upon the Operation of Prostatectomy.

It is now possible to discuss with some promise of accuracy the anatomy of the operation which Mr. Freyer claims as a total prostatectomy. Is this operation a complete removal of the "entire prostate within its capsule," or is it merely a shelling-out of adenomatous nodules from within the prostate itself, as some would have it? Much confusion has arisen in discussing this question owing to the indefinite use of terms denoting the true capsule of the prostate and the envelope provided by the pelvic fascia. This has in the main, I believe, resulted from a want of clearness in the descriptions of our anatomical text-books. Both those layers have been described without distinction under the term capsule, although they are structurally and morphologically distinct.[2] It has recently been suggested that the true capsule of the prostate should be termed the

[1] 4533c. R.C.S.M.

[2] Cuneo et Veau, 'Journal de l'anatomie,' 1899, No. 2.

"cortex,"[1] and again that a special name—the "surgical capsule"—should be applied to the structure surrounding the enlarged prostate.[2]

In regard to the first proposition, the term "cortex" is certainly unfortunate. It has already been used in an entirely different meaning in reference to other glands and organs in the body. The brain, the kidney, and the supra-renal gland each have a cortex which does not convey the impression of a fibrous or muscular envelope. Rightly or wrongly, the term cortex has been applied to the outer layers of the parenchyma of an organ which, although differing somewhat from the central portion in structure, do not partake of the nature of a portion of the connective-tissue framework. No less unfortunate is the term "surgical capsule," which has been suggested for a circular layer of compressed prostatic tissue supposed to surround the enlarged prostate. If such a layer existed there would be more reason to call it pathological than surgical. But there is no proof to my mind that the layer ever exists as a capsule at all.

Sir Henry Thompson many years ago supplied a term which amply fulfils all requirements and distinguishes the fascial envelope as the "sheath" from the outer margin of stroma, which is the "capsule," and corresponds to the capsule of other glands. Definition of these terms has become necessary, for it has been sufficiently evident that, by some at least, their meaning has not been thoroughly grasped.

When the evidence of completeness or incompleteness of the operation is considered, it is found that a small nodule was described adhering to the wall of the sheath after removal of the prostate. Further, it was noted that in the microscopic section the capsule was torn open at one part and a nodule of prostatic tissue exposed, and on examining the total number of enucleated prostates the appearance of one or two of them would lead one to expect

[1] Shattock, 'Brit. Med. Journ.,' Oct. 24th, 1903, p. 1701.

[2] Wallace, 'Lancet,' Dec. 5th, 1903, p. 1578.

that some part of the capsule or shred of prostatic tissue had been left behind. It is therefore apparent that in a few cases portions of the enlarged prostate have been left behind. Is it to be inferred from this that this operation of prostatectomy is an incomplete one? I think not. It must be sufficiently evident that in the vast majority of these specimens there is no question of nodules of prostatic tissue being left behind. Nor were the post-mortem specimens of the sheath studded with such nodules. The pin-head sized nodule described was the only portion of prostatic tissue found after careful search. The accidental tearing away of such a nodule from the main mass during the operation does not in my opinion vitiate the completeness of the operation.

The question which really arises for discussion is not whether a shred of prostatic tissue is left behind in two or three of seventy-odd operations, but whether the line of cleavage of the operation passes between the prostatic capsule and its sheath, or whether it passes along some plane within the capsule or even within the enlarged gland.

The material I have brought forward and discussed in detail shows that the mass of tissue removed at the operation consists of the whole of the enlarged prostate, whether it is in the form of two entirely extra-vesical lobes, or whether there is in addition a small or large intra-vesical portion. That this mass is surrounded by the thickened prostatic capsule, and in a few specimens portions of the bladder muscle are also removed. Further, that the parts left behind consist of the prostatic sheath, between the layers of which lie the prostatic plexus of veins.

The plane followed by the enucleating finger is therefore as follows:—After scraping through the mucous membrane covering an intra-vesical projection, the finger meets the capsule of the prostate and passes along outside this, stripping the mucous membrane from off it. Keeping always to the capsule, the finger now passes through the lumen of the vesical sphincter, and is guided by these

structures between the prostatic sheath and the prostatic capsule.

The finger can now be swept round each lobe, and the following structures must be torn through before the prostatic mass lies free in its sheath:—The ejaculatory ducts, the vessels which pass out from the upper part of the postero-lateral horns, the vertical band of the muscle of Henle, and the urethra. Variations in the treatment of the urethra have already been described in detail. The strength of the anterior commissure and, to a less extent, of the urethral wall determine the fate of that tube, and the desire of the surgeon to leave it intact must be subservient to these factors.

If no intra-vesical portion be present the finger must tear through the muscle of the bladder base before reaching the prostate, but this manœuvre is rendered easier than in the normal condition by the increased bulk of the prostate, over which the muscle-fibres are stretched.

It has recently been stated[1] that "after the so-called total extirpation of the prostate an envelope formed of expanded prostatic tissue was doubtless left behind, and bounded the cavity formed by the removal of the tumour;" and again, "that the parts removed might consist of adenomata from the lateral lobes or of an adenomatous mass surrounding the urethra," and "that there was always left behind a definite laminated envelope containing gland-matter." It is therefore contended that the specimens looked upon as enucleated prostates are merely adenomata removed from within the lobes of the prostate, the latter having been compressed into a fibro-glandular capsule of many layers and left behind at the operation.

It is permissible to ask at the outset why two adenomata should take with such surprising regularity the form and outline of the prostatic lobes, and why there are not five or even ten right and as many left lobes. In my experience the adenomatous prostate is made up primarily of two main masses of small adenomata, which correspond to the two

[1] Wallace, loc. cit.

lobes of the prostate. Outgrowths from these may or may not protrude into the bladder, but, taking a very large number of adenomatous prostates, they conform with striking regularity to the two lobe outline. If these two lobes are to be looked upon as individual adenomata which have crushed aside the remaining gland-tissue to form a complete circular capsule for their joint use, such precision of adenomatous growth is, I think, unparalleled in pathology. It is necessary to examine, however, the material on which these statements in regard to the operation of prostatectomy are based.

If I read the report in question aright, the theory is built upon the examination of two specimens of enlarged prostates removed after death and certain manipulations performed upon these.

I do not for a moment doubt the accuracy with which these manipulations have been described, but only the sweeping conclusions in regard to the operation of prostatectomy which have been based upon them, and which apparently have received a considerable measure of acceptance.

It is surely unnecessary to point out that these conclusions are not based upon any operation claimed to be a prostatectomy, but merely upon certain anatomical exercises performed upon post-mortem specimens. The only relation they might have to the operation under consideration is by analogy—a line of argument at all times liable to error.

What evidence is there in the operation specimens examined for the purpose of the present investigation to support or confute these statements?

In describing the enucleated prostates it was noted that a few gland-tubules might sometimes be found wedged into the capsule, and the view was expressed that in the re-arrangement of the internal economy of the lobes a few tubules might be expected to be pushed aside, the more so that in the normal gland the tubules may approach very near the surface of the capsule at some part. That

the enucleated prostates were surrounded by a capsule of such compressed gland-tubules I have already denied.

On examining the specimens of the sheath after prostatectomy there is again no evidence in support of such a theory. No layers of compressed gland were found, and, further, the small nodule which was left adhering to the sheath in one specimen showed without possibility of cavil that it was neither itself compressed nor was it separated from the sheath by compressed gland-tissue.

An important landmark in regard to the plane of cleavage in the operation is the voluntary muscle of Henle. This striped muscle has been accurately traced between the sheath and the capsule of the normal prostate. The lower portion of it has been found lining the floor of the cavity after removal of the prostate, and the anterior vertical prolongation of the same muscle has been found adhering to the front of the prostatic capsule of an enucleated prostate.

It is therefore possible to dismiss such statements as those above referred to so far as the operation under consideration is concerned.

According to the evidence I have brought forward, the line of cleavage in this operation lies between the capsule of the prostate and the sheath. The prostatic plexus of veins, which only comes in relation to the field of operation along the front of the sheath, is amply protected in its position between the layers of the sheath by a layer of this fascia.

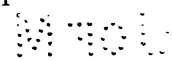
It is not to be supposed that in every case this operation is absolutely faultless. I have already shown that in a few cases a shred of prostatic tissue is left behind. But I submit that the operation represented by these specimens is a complete prostatectomy, and that small portions of prostate left behind are accidents of the operation and not proofs of its incompleteness.

DISCUSSION.

Mr. Reginald Harrison spoke purely from the surgical standpoint. Was the operation an entire prostatectomy, or merely a shelling out of adenomatous lobules? His specimens illustrated both these varieties. In some cases the patients had not only made a good recovery, but at the end of a year there were no physical signs of a prostate to be detected. In other specimens there was evidence that a ring of prostatic tissue had been left behind, but no recurrent hypertrophy had followed.

Mr. Cuthbert S. Wallace was in perfect accord with the anatomical points in the paper. The organ completely surrounded the urethra. The thickening of the recto-vesical fascia he had not seen, but it was doubtful whether the same thing was always meant by this term. Many enlarged prostates could not be enucleated; they had to be cut out, and if the contention of the paper were true they should come out easily. If the adenomatous change were uniform there would not be easy shelling out, but if it were local there would. It was admitted that normal prostates could not be enucleated, and enucleation was only possible by the "shaking loose" of the gland by enlargement. He asked how Mr. Walker accounted for the fact that specimens weighing little more than the normal weight were enucleated as easily as large ones. He next dealt with the question whether the operation was a complete prostatectomy. Mr. Walker in one of his specimens had found a small adenoma in the capsule that was left behind, and was of the opinion that it was not simply a portion of gland tissue torn from the central adenomatous mass removed at the operation, but was a distinct mass of gland tissue. Now the operation performed in this case was called a total prostatectomy, yet there was left behind a distinct encapsuled adenoma. The inference was obvious; the capsule left behind represented part of the prostate, since the adenoma in question could only have arisen from pre-existing gland tissue. Histologically, therefore, the prostatectomy was not complete. In Mr. Walker's own words, "Outside the nodule is a well-marked layer of tissue which is evidently a portion of the capsule of the prostate." The question was, how far was it possible to remove the adenomatous growths and yet leave the urethra intact. When small they might be thus removed, but not when large. The adenomata were compound, the two oval masses being composed of compressed small adenomata.

Mr. F. Swinford Edwards asked in regard to the muscle of Henle where the longitudinal fibres terminated? Also whether in point of fact an adenomatous nodule was found in the sheath?



Some cases of enucleation were no doubt extra-capsular, and some were intra-capsular. In some cases muscle fibres were found on the outer surface of the specimens removed, and in such the enucleation must have been outside the capsule and within the sheath. The whole question depended on what plane the surgeon entered, but in either case great relief was given from the obstruction to micturition. In properly selected cases the operation was highly to be recommended.

Mr. A. PEARCE GOULD also thought the surgical distinction between an extra-capsular and an intra-capsular prostatectomy was unimportant. The nature depended on the exact plane which the surgeon happened to hit. He had had in his own experience examples of both types of operation. The value of the operation was extreme.

Mr. J. G. PARDOE thought the chief difficulty in accepting the completeness of the operation was because nodules were left behind, but this was not remarkable, as it was known that the adenomatous mass might burst its way through its coverings, and come to lie directly under the mucous membrane alone.

Mr. P. J. FREYER congratulated Mr. Thomson Walker on his eminently practical paper, which had evidently cost him much labour and thought, and was well worthy of the traditions of the Society. The question as to whether his (Mr. Freyer's) operation was a complete prostatectomy, or, as had been suggested by some, one in which a thin layer of the outer rim of the prostate was left behind, was a purely academic one, and did not in any way detract from its practical merits, for no one could now deny that the results of the operation were eminently satisfactory. Mr. Walker's researches had, however, definitely proved what he had from the beginning held—that his operation was a complete prostatectomy. The evidence on which Mr. Freyer had based his conclusion might be summarised as follows:—(1) The general conformation of the specimens removed by him in some ninety cases of the operation, a large number of which were placed before the Fellows for inspection. (2) The absence of any palpable prostatic substance in the cavity that remained at the time of operation, as felt between a finger in this cavity and a finger in the rectum—a very thin membrane, consisting merely of the bowel and the sheath of recto-vesical fascia, lying between the points of the fingers. (3) The absence of any mass resembling prostatic tissue in the cases operated on, at any period after the operation, on examination by the finger in the rectum. (4) When the enlarged prostate projected prominently in the bladder the true capsule was at once reached by scraping through the mucous membrane by the finger-nail. Following the outer aspect of this capsule by pushing the finger through the lumen, outside the bladder, in the plane between it and the sheath, the organ was enucleated in its capsule. Now, if a layer

of prostate had been left behind extra-vesically, this layer must necessarily extend intra-vesically, but in practice no such layer was found in the bladder, but merely mucous membrane. (5) The absolute and complete relief of the symptoms, no matter how many years the patient had been dependent on the catheter, after the operation. Mr. Walker had now supplied the most cogent evidence of all, viz. that no layer of prostatic tissue is found in specimens removed from the bodies of persons on whom the operation had been performed during life. The fact that occasionally a minute nodule or tuft of prostatic tissue is accidentally left behind, owing probably to inflammatory adhesion between the sheath and capsule, is no proof that the prostate is not enucleable as a whole. As well might it be argued that the edible portion of an orange is not enucleable entire from the rind because occasionally, through under or over ripeness, a small mass of the pulp and capsule is left adherent to the rind. Since he (Mr. Freyer) introduced his operation to the notice of the profession at large in July, 1901, Mr. Wallace had often criticised the operation, and he regretted to find associated with his name that of Mr. Shattock. He had neither the time nor the inclination for controversy in the medical press, but he had from time to time published full details of series of cases of his operation, so that the profession might judge of its merits; and the profession at large had not been slow to recognise the value of the operation, in spite of the deprecatory remarks of these gentlemen. In August last Mr. Shattock wrote to him asking his permission to read a paper at the Pathological Society on some of the specimens of prostates, which, at Mr. Shattock's repeated request, he had presented to the College of Surgeons' Museum. "I think," Mr. Shattock wrote, "that the examination of that beautiful one (prostate) that I cut in two will quite satisfy you in your contention *re* the capsule being removed with the gland tissue." His surprise can be imagined when a few weeks after he read in the medical journals that at the meeting Mr. Shattock had expressed an entirely different view, viz. that his operation was not a complete prostatectomy. The falsity of this latter view had been completely demonstrated that evening; but he regretted that Mr. Shattock was not there, so that he might explain his own conflicting views on the subject. It seemed a pity that an officer in Mr. Shattock's responsible position should have rushed to a rash conclusion before having had an opportunity of examining a post-mortem specimen from a patient on whom his operation had been performed during life. Turning to Mr. Wallace—what was the evidence on which Mr. Wallace based the conclusion that his operation was not a complete prostatectomy? Mr. Wallace did not seem to have once performed his operation on the living subject, but confined

himself to operating on the dead, the contents of the pelves of which were placed in spirit, and, when so hardened, Mr. Wallace proceeded to perform prostatectomy thereon after his own methods. He need scarcely say that there was no analogy between an operation performed on the living subject, whilst the tissues were warm, the capsule and sheath strong and unyielding, and the connecting tissues in the line of cleavage between them soft and easily broken down by the finger, and an operation performed on a hardened jar specimen, and he thought experience of this kind was inadequate to controvert the results of a surgical method on the living tissues. Mr. Wallace asked how it was that he removed prostates of an ounce in weight, or even less, as readily as large ones, seeing that enucleation was only possible by the shaking loose of the gland by enlargement? This was easily explained. Sir Henry Thompson found, from examination of some two hundred normal prostates by himself and Dr. Messer, that the average weight was about 4½ drachms; but this included the weight of the sheath of recto-vesical fascia, whereas the latter was left behind in his operation. The average weight of the prostate included in the true capsule,—which corresponded with what was removed in his operation,—was considerably less than this. Now some of the normal prostates referred to weighed only about 2 drachms, whereas others weighed 6 or 7 drachms. The portion included in the capsule of a prostate weighing, with its sheath, 2 drachms, would probably not weigh more than 1 drachm; this, if enlarged to a size weighing 1 oz. would be relatively as enlarged, and might cause just as severe symptoms, as a prostate of 6 drachms enlarged to 3 or 4 ounces, and might be as easily enucleable. Most of the speakers that evening had acknowledged that the enucleation of the enlarged prostate in its capsule was feasible, though some of them had held quite a different view when his operation was first brought to the notice of the profession; but they said that sometimes adenomatous masses were removed from within the capsule. His reply was that in these latter cases the fault did not lie in his operation, but in the method of its performance.

Mr. Thomson Walker, in reply, thanked those gentlemen who had discussed the paper. In regard to the points which Mr. Wallace had raised he protested against the introduction of additional names for the layers around the prostate. The nomenclature suggested by Sir Henry Thompson was concise and comprehensive. He had examined many enlarged prostates, but had not found the capsule of compressed gland tissue for which the term "surgical capsule" had been suggested. When Mr. Wallace's illustrations were compared more closely with his own it was found that the line of cleavage in the former passed well inside the layers surrounding the specimens of enucleated prostates he had exhibited. It was therefore probable that Mr.

Wallace's contention that he only shelled out adenomata was correct so far as his own specimens were concerned. The specimens Mr. Thomson Walker had exhibited showed on the other hand a line of cleavage which passed between the sheath and the capsule in most cases. In a few this perfect operation had not been attained, but in others even more had been removed, for part of the bladder base was seen on the prostrate after enucleation. He therefore maintained that the operation represented by those specimens must be termed a complete prostatectomy.

Thomson Walker: Normal and Enlarged Prostate. Plate I.

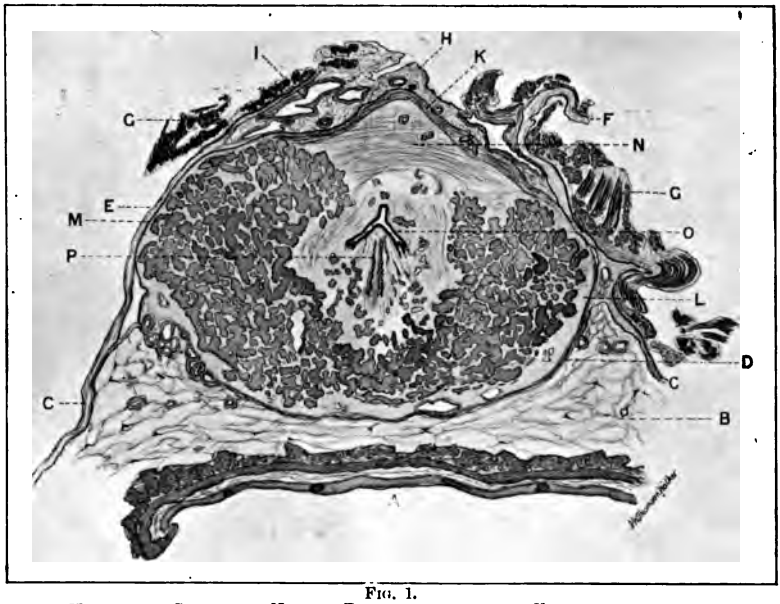


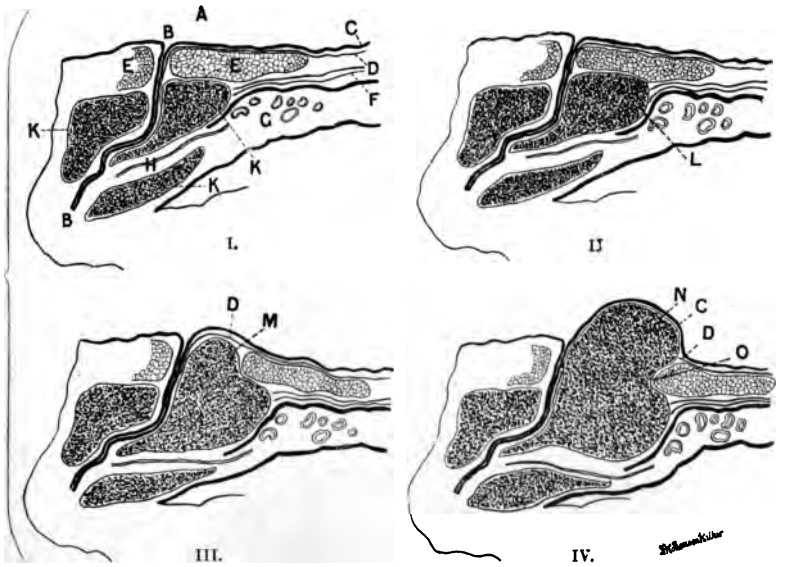
FIG. 1.

HORIZONTAL SECTION OF NORMAL PROSTATE AT LEVEL OF VERUMONTANUM. X 3.

A—Wall of rectum. B—Areolar tissue between rectum and prostate (in excess in this specimen). C—Visceral layer of pelvic fascia. D—Recto-vesical layer of pelvic fascia. E—Layer of pelvic fascia in lateral aspect of prostate. F—Reflexion of E from prostate. G, G—Levatores ani. H—Layer of fascia on anterior aspect of prostate. I—Vein of prostatic plexus between layers of H. K—Layer of striped muscle. L—Capsule of prostate. M—Gland tubules approaching surface of capsule. N—Anterior commissure. O—Urethra showing verumontanum. P—Ejaculatory ducts.

NOTE.—D, E, H—Sheath of prostate.

FIG. 2.



SERIES OF DIAGRAMS TO ILLUSTRATE CHANGES IN RELATIONS OF THE ENLARGING PROSTATE.

I.—*Tracing from vertical anteroposterior section through normal prostate.* A—Bladder cavity. B, B—Prostatic urethra. C—Bladder mucous membrane. D—Inner longitudinal bladder muscle. E—Sphincter of bladder. F—Outer longitudinal bladder muscle. G—Seminal vesicle. H—Ejaculatory duct. K, K, K—Prostatic gland tissue.

II.—*Early stage of enlargement.* L—Wedge of prostatic tissue separating seminal vesicle from bladder base.

III.—*Early stage of enlargement.* M—Nodule of prostatic tissue dilating sphincter of bladder. O—Inner longitudinal layer of bladder muscle still covering M.

IV.—*Late stage of enlargement.* N—Large intra-vesical nodule of prostate covered only by—*C—Bladder mucous membrane.* D—Inner longitudinal layer of bladder muscle through which *N has burst.* *O—Groove in enlarged* prostate formed by bladder sphincter.

FIG. 3.

POST-MORTEM SPECIMEN AFTER PROSTATECTOMY.

A—Bladder. B, B—Openings of ureters. C—Sphincter of bladder. D, D—Cavity left after removal of prostate. E, E—Prostatic urethra torn across at verumontanum. F—Ejaculatory ducts. G—Outer layer of sheath. H—Vein of prostatic plexus. I—Inner layer of sheath. K, K—Striped muscle (of Henle). L, L—Levatores ani.

FIG. 4.

VERTICAL SECTION THROUGH WALL OF CAVITY AFTER PROSTATECTOMY.

A—Bladder wall showing layers. B—Bladder mucous membrane. C—Right half of cavity left after removal of prostate. D—Position of urethra. Small portion of urethral mucous membrane opposite D. E—Fibrous sheath. F—Vein of prostatic plexus between layers of E. G—Constrictor urethrae. H—Muscle of Henle on urethra. I—Striped muscle on floor of cavity. K—Bladder muscle in wall of cavity. L—Nodule of prostatic tissue.

FIG. 5.

ENUCLEATED PROSTATE. CLOSED FORM. ANTERIOR VIEW.

A, B—Right and left lobes. C—Catheter lying in urethra. D—Ridge of striped muscle. E, E—Groove separating intra- and extra-vesical portions. F—Middle lobe. G, G—Deep grooves in which lie bands of muscle.

FIG. 7.

ENUCLEATED PROSTATE. OPEN FORM. ANTERIOR VIEW

A, B—Smooth inner surfaces of lobes. C—Posterior wall of urethra from vesical orifice to—D—Just above position of verumontanum. E—Space between lower poles of lobes in which urethra is wanting. F—*Position* of catheter in urethra.

FIG. 6.
HORIZONTAL SECTION THROUGH ENUCLEATED PROSTATE. x 3.
A—Urethra. B—Verumontanum. C, D—Right and left lobes. E—Small cystic adenoma. F—Capsule, anteriorly. G—Capsule, lateral. H—Anterior commissure. K—Line of separation. L—Tear in capsule.

ANÆMIA PSEUDO-LEUKÆMICA INFANTUM

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IN the year 1889 von Jaksch published an account of a form of anæmia in a young infant, which in his opinion constituted a distinct type. It closely resembled true leukæmia, but there were certain characteristic symptoms which differentiated it from that disease. He accordingly proposed for it the name anæmia pseudo-leukæmica infantum. In his original description the chief characteristics of the disease were a marked enlargement of the spleen, a moderate enlargement of the liver, occasional enlargement of the lymphatic glands, together with a blood change consisting of a marked leukocytosis and a great diminution in the number of red corpuscles. The publication of this case has given rise to a very considerable literature, devoted for the most part to the consideration of the question whether von Jaksch's anæmia is a primary or a secondary blood disorder, owing its peculiar characteristics to the accident of its occurrence in infancy. On the one

hand it is contended that any anæmia in infancy, *e. g.* that of rickets or of congenital syphilis, may under certain conditions take on this form; on the other, that it is a primary anæmia, a disease *sui generis*, and that rickets or congenital syphilis are concurrent accidents. An attempt is made in this paper to show that it is a "primary" anæmia of infancy, distinguishable from all other anæmias of that age both by its clinical course and by characteristic changes in the blood.

The disease has not in this country received much attention, and with the exception of Dr. Fowler's paper, read at the meeting of the British Medical Association in 1902, no large series of complete cases with blood-counts has been published.

We have had the opportunity during the last nine years of examining a number of cases of this nature. All but two of the children were patients either at St. Bartholomew's Hospital or at the Hospital for Sick Children, and to the physicians of these two hospitals we are indebted for permission to make use of the cases.

Two tables are appended, one (A) containing a list of the prominent symptoms, and the other (B) containing a more detailed exposition of the condition of the blood. Table B contains two cases not included in Table A.

The cases are, as a rule, distinguished at a glance from other forms of anæmia. The pallor, always profound, is of a waxy character, often with a slight olive or yellowish tint. The children are sometimes wasted, but more often retain a considerable amount of subcutaneous fat; their movements are slow and uncertain, and they often seem too listless to betray irritation when examined. The abdomen is always greatly enlarged and protuberant, the enlargement being chiefly due to the enormous size of the spleen. A majority of all cases are spotted with petechial hæmorrhages on the limbs and trunk. The patients usually eat and sleep well, but their general condition scarcely varies from day to day, except when attacked by diarrhœa, bronchitis, or some form of hæmorrhage.

The condition is essentially chronic, and no marked improvement must be expected for several months. When, however, convalescence is begun, recovery is extremely rapid and complete. The children grow fast, and soon become to all appearances normal; the spleen, however, may remain palpable and unduly firm, even after a lapse of several years.

Age of the patient.—The age at which our cases came under observation varied from seven months to three years, but a very large proportion of them fell within the second year of life, the average age being eighteen months. Without exception the disease, as judged by the great splenic enlargement and the condition of the blood, was already fully developed when the patients were first seen. This circumstance renders it probable that the average age at the date of onset as stated is somewhat too high.

Mode of onset.—The onset of the disease is always gradual. Attention is called to the condition by increasing pallor or swelling of the belly, sometimes accompanied by wasting, or more rarely by œdema.

In three of the cases the commencement of the illness was dated from a nose-bleeding some weeks before. In all three cases this was repeated more than once during the course of the disease, and may be regarded as an effect and not a cause.

In one case a petechial eruption was the first sign noticed, but when the patient was seen two days later the spleen was already greatly enlarged and very hard.

Tendency to hæmorrhage.—In all the cases but six some form of hæmorrhage was present during the course of the disease. In the majority it showed itself as a petechial eruption in the skin distributed indifferently, sometimes all over the body, sometimes on the limbs alone, or on the trunk, and in one case on the hard palate. The spots were, as a rule, quite small, and in the earliest stage in one case simulated the eruption of measles on the face. Larger subcutaneous hæmorrhages we have only once seen.

Hæmorrhage from the mucous surfaces is less common. Five of the cases suffered from epistaxis. In all these cases the bleeding was repeated and profuse; in two of the cases sufficient to endanger life. In Case 3 the gums were spongy and bled, and in one case (2) blood was passed by the bowel on one occasion. In no case was there any evidence of subperiosteal hæmorrhage or tenderness of bones.

The spleen.—The splenic enlargement was always considerable; in one case only did it stop short of the iliac crest, and in most cases reached the mid-line or even went beyond it. It was always very hard and firm.

The liver.—The liver in about two thirds of the cases was apparently enlarged but twice; at least in these cases at the post-mortem examination the liver was found of normal weight. The truth is that in infants with distended abdomens and wide costal angles it is very difficult accurately to gauge the size of the liver. Still, no doubt in a certain number of cases the liver is enlarged, though usually only in a moderate degree.

The glands.—Excluding certain cases where some local cause existed, *e. g.* recent vaccination, to explain its occurrence, glandular enlargement was only once observed during life, but at the post-mortem four of the five cases in which such examination was made showed considerable enlargement of the deep glands. In all four the mesenteric glands were large and congested, and in one case the bronchial and tracheal also.

Fever.—Persistent irregular fever was present in nearly all the cases, lasting sometimes for several weeks, and disappearing gradually before convalescence. In two of the fatal cases, however, the fever was only slight. In one case (6) it was absent throughout, but all the symptoms pointed to a mild or disappearing attack.

Œdema.—In six of the cases there was at one time or other some œdema, usually of the feet and legs, but in one case affecting the hands also. It was never very marked, and when present would appear and disappear

intermittently without obvious cause. In addition a puffy condition of the face is an almost constant feature.

Wasting.—Some degree of wasting was present in the majority of the cases, four times in a marked degree. Sometimes it appeared early, and was the first symptom to attract attention; sometimes later, and then often as the result of diarrhœa. In one fatal case the fat was well preserved at death, and the body was described as well nourished. In several cases the weight remained stationary for months while the patient was under observation.

Diarrhœa and bronchitis.—One or other of these complications was almost invariably present at some period of the illness, and usually determined the issue in the fatal cases.

Treatment.—As can be seen in Table A, the treatment varied considerably. In a disease the cause of which is unknown, treatment must necessarily be directed to the alleviation of symptoms, and arsenic, cod-liver oil, iron, bone-marrow, and raw beef juice, which appear most frequently in the list, tell their own tale. It cannot be said that the employment of any of these modes of treatment had an appreciable effect on the course of the disease.

The condition of the blood.—The changes present are set forth in Table B appended to the paper. Therein are included observations made at all stages of the disease in cases of all degrees of severity. For this reason, perhaps, an average of the whole gives an accurate picture of what may be expected in cases of ordinary severity during the active stage of the disease.

It cannot be too strongly emphasised that in health and disease the red and white cells of the blood vary quite independently of each other, that any factor may act on one or other alone, and, if acting on both, need not act in the same direction. The statement of the ratios existing between the two classes is therefore not only misleading, but fatuous.

The red cells.—The average number in forty-seven counts in twenty-three cases was 2,900,000.

The highest numbers were 4,800,000 in a convalescent, and 4,632,000 found in the earlier stages of a case ultimately fatal. The lowest, 918,000, was found shortly before death in another fatal case. The diminution in numbers rarely approached that seen in pernicious anæmia, and alterations in shape and in staining reactions were not as a rule at all prominent.

Nucleated reds were always present in the active stages. They cannot be said to bear any numerical relation to the total number of red cells present, nor does their number give any indication as to the severity of any given case; still, as would be expected, they vary directly with the other symptoms, increasing or decreasing in individual cases as the general condition of the patient grows worse or better.

Large nucleated red corpuscles, the so-called megaloblasts, which are not found in the healthy body, even in the bone-marrow, after birth, are frequently present, and may exceed in number the normoblasts. In either variety the nuclei may show great irregularity of form; they are often multiple, and not infrequently give evidence of mitosis.

Hæmoglobin.—The average percentage for all counts was 37 per cent. of the normal, and always showed a diminution disproportionate to that of the red cells. The average colour index was ·6, but in milder cases reached ·8 or over. On the other hand, in one fatal case, where the reds fell to 918,000 per c.mm., the percentage of hæmoglobin did not fall in the same degree, and the colour index, as a consequence, rose to one before death.

Leucocytes.—The average number of leucocytes was 24,100. The increase affects all forms, though not equally, the result being that there is, with the greater increase of the lymphocytes, an apparent, though in reality merely a relative, decrease in the number of the polymorphonuclear variety.

The average percentage of polymorphonuclears in

thirty-two counts was 44·6, and except during convalescence it rarely reached 50 per cent.

In Table B the percentages of small and large lymphocytes is given separately, and it will be seen that the increased proportion of the cells is due almost entirely to the greater relative increase of the small form. Together the average percentage was 46·2.

Myelocytes.—In addition to the normal hæmal leucocytes, myelocytes make their appearance and form a characteristic feature of the blood condition.

In no other disease except myelogenic leukæmia are they so constantly present in such large numbers, or in such a high proportion. The average percentage for all our counts was 5·7. Excluding convalescent cases the lowest percentage was ·6 in Case 14, and the highest 13·8 in Case 20.

Eosinophiles.—The absolute number of these cells is increased along with the other varieties, but the percentage is not as a rule altered. In one case during convalescence 9 per cent. was on one occasion reached.

Conclusion.

It is perhaps hardly necessary to say that we believe an unbiassed examination of these cases must lead to the opinion that we are dealing with a disease *sui generis.* That these infants should often be, at the same time, the subjects of rickets or congenital syphilis is in no way surprising, having regard to the social class to which they almost invariably belong. It may be that both these diseases, to mention no others, render children more liable to the affection under discussion, but this by no means proves that it is secondary to these complaints. To say that anæmia pseudo-leukæmica infantum is secondary to rickets, or any other disease, if it means anything should mean that if the rickets be cured the anæmia will disappear. This is very far from being the case. No disease yields more readily to treatment than rickets, and yet in many instances under careful

treatment in hospital these cases showed no improvement for months, and eight cases out of twenty-three terminated fatally.

Of the complete cases in Table A, seven out of the twenty-one showed no evidence of rickets, and any blood examinations which we have made on rickety children, however severely affected, show an entirely different picture.

Not only is this the case in rickety anæmia without enlargement of the spleen, but even where the spleen can be felt two or more inches below the costal margin the condition of the blood remains that of a simple rickety anæmia, and there is no trace of resemblance to the condition which we have described as characteristic of pseudo-leukæmia. If this disease is secondary to rickets it is difficult to understand why the changes in the blood should not be graduated from the slight to the severe types, instead of presenting a marked contrast.

The history of infantile scurvy is sufficient proof of the extreme frequency of rickets in all cachexias about this age, and of the danger of drawing hasty conclusions from this fact.

As for congenital syphilis, in only two cases was there any evidence of a syphilitic taint, and then only of a doubtful nature. One case (3) was indeed treated with mercury for a lengthened period without benefit, and in spite of it the disease persisted for sixteen months. The argument used above as regards the blood condition in rickets applies also to congenital syphilis and to infantile scurvy. In Table C some counts in these conditions are appended for the purposes of comparison.

Some authors have maintained that anæmia, induced by any cause, for example chronic diarrhœa, if severe enough, may assume the type under discussion. The fact that none of the ordinary causes of infantile anæmia is noted in the history of the majority of these cases appears to us a sufficient answer to this contention.

Its relation to myelogenic leukæmia.—The great splenic

Nu	11.	12.		19.	20.	21.
Ag	20 months	2 years	os.	2 yrs. 3 mos.	2 years	10 months
Se	M.	F.		M.	F.	M.
On	Swollen belly 10 weeks	Lump in side 14 days	is s ly	Pallor 14 days before	Abdomen swelling 8 months	Wasting 4 months
Ri	Yes	Yes	l	Slight	Marked	Slight
Sy	No	?		No	No	No
D.	Attacks of D.	No	a	No	Yes	No
Fe	Suckled up to present	?	n a	?	Artificial foods	Breast-fed 3 months
W	No	No	e	Slight	Slight	Considerable
Ha	Petechiæ	Profuse	s	Numerous	No	No

enlargement, the persistent and often high leucocytosis, with the presence of large numbers of myelocytes render it liable under certain circumstances to be confounded with myelogenic leukæmia. In this form of true leukæmia, however, even when occurring in young children, the number of leucocytes almost invariably at some stage of the disease is much higher than in pseudo-leukæmia, and the percentages of myelocytes, excepting very rarely during remissions, is at least twice as high as our highest count.

Apart from the condition of the blood the history of the disease is different. It is in the highest degree improbable that a disease relatively common in infancy, which terminates in recovery in the majority of cases, should cease at a certain age period (for leukæmia of any kind is exceedingly rare in children between the ages of three and ten) and then reappear in a different form in later years.

TABL

No. of case.	Sex.	Date.	No. of red corpuscles.	Hæmoglobin percentage.	Colour Index.	No. of leucocytes per c.m.	Polymorph. nuclear.
				Per cent.			Per cent
1	F.	1895. May 8	2,044,000	25	·53	44,000	33
		„ 16	2,060,000	22	·53	42,000	34
		July 27	2,152,000	22	·51	54,000	35
		Oct. 18	1,621,000	19	·58	13,000	—
		Nov. 29	3,775,000	43	·58	10,000	52
2	M.	1898. Aug. 30	3,720,000	55	·7	9,500	47·5
3	F.	1898. Sept. 1	2,700,000	35	·6	14,000	49
		1899. July 18	2,310,000	38	·8	17,000	50·3
		„ 27	2,750,000	45	·8	15,000	48
4	M.	1894. June 12	1,600,000	30	·9	59,000	35
		„ 28	2,000,000	35	·8	20,000	38·5
		Oct.	918,000	20	1	41,000	38
5	F.	1896. Nov.	3,280,000	37	·5	13,000	42·5
6	M.	1898. June	3,520,000	60	·84	10,500	57
7	M.	1899. Nov.	3,840,000	35	·48	19,000	55
8	F.	1900. March	4,530,000	58	·6	24,000	37·5
		April	4,632,000	55	·59	30,000	38
		June	2,965,000	47	·7	7,000	—
		July	2,685,000	37	·69	13,000	—
		„	2,600,000	33	·6	7,000	40
9	M.	1900. Aug.	2,800,000	35	·62	72,000	73
10	M.	1902. June	3,000,000	45	·75	25,000	23
11	M.	1902. Nov.	3,750,000	35	·46	21,000	46
12	F.	1903. May	2,650,000	30	·5	8,000	47·5
13	F.	1899. Nov.	2,972,500	—	—	21,000	46
14	M.	—	3,720,000	—	—	35,000	63
15	F.	March 21	2,805,000	33	·6	24,000	47·5
		April 11	1,584,000	31	1	21,000	—
16	M.	—	3,086,000	48	·7	11,000	40·1
17	M.	Jan. 4	2,324,000	30	·6	14,000	56
		„ 19	1,816,000	—	—	18,000	—
		„ 26	2,100,000	32	·7	20,000	—
		Feb. 5	2,400,000	32	·8	24,000	—
		„ 10	2,320,000	38	·6	32,000	—

B.

Lympho-cytes.	Large mono-nuclear.	Eosino-philes.	Myelo-cytes.	
Per cent.	Per cent.	Per cent.	Per cent.	
52	7	1·5	6·5	2250 p.c.m.
51	8	3	4	4400 „
51	10	2	2	2300 „
—	—	—	—	—
38	7	3	0	—
40	7	2	3·5	A few large and small.
35	7	3	6	970 p.c.m., 60 per cent. megaloblasts.
27·6	8	4·3	6·3	650 p.c.m., mostly megaloblasts.
30	10	5	7	—
42	8·5	4	6·5	A few nucleated reds.
45	7·5	3	6	—
44	8	3	7	1150 p.c.m., mostly large.
35	12	2	7·5	100 p.c.m.
21·5	16·5	1·5	3·5	400 megaloblasts; 50 normoblasts p.c.m.
32	8·5	·5	4	850 p.c.m., large and small in equal numbers.
43	11	·75	7·25	60 p.c.m.
45	9	1·5	6·5	A few.
—	—	—	—	—
—	—	—	—	—
42	10	2	6	540 p.c.m.
11·5	6·5	0	9	—
60	7	2	9	—
43	2·5	1	7·5	1470 megaloblasts; 630 normoblasts to p.c.m.
32	9	3·5	8	—
39	11·3	·3	3·3	Many both large and small.
20·3	14	·6	·6	—
34·2	10·6	·5	6·1	A few nucleated reds.
—	—	—	—	—
41·3	13·5	·8	3·1	A few nucleated reds.
30	3	—	3	A few nucleated reds.
—	—	—	—	—
—	—	—	—	—
—	—	—	—	—
—	—	—	—	—

TABLE

No. of case.	Sex.	Date.	No. of red corpuscles.	Hæmoglobin percentage.	Colour Index.	No. of leucocytes per c.m.	Polymorph. nuclear.
				Per cent.			Per cent.
		March 2	3,000,000	36	·6	25,000	—
		„ 12	3,505,000	40	·5	24,000	—
		„ 20	3,500,000	40	·5	20,000	—
		„ 28	3,900,000	48	·6	16,000	—
		April 12	4,800,000	56	·6 ·4	14,000	—
18	M.	July 20	3,312,000	28	·6	36,000	38·4
		Nov. 21	3,600,000	48	·7	6,500	—
		March 22	3,316,000	49		10,000	—
19	M.	—	3,580,000	40	·5	15,000	56
20	F.	—	4,072,000	32	·4	52,000	41·1
21	M.	—	3,835,000	23	·3	15,000	41·8
22	M.	1900. Feb. 2	1,962,000	29	·98	38,500	45
		„ 15	1,520,000	25	·83	28,000	45
		March 15	2,801,250	35	·62	21,750	54
23	F.	1899. Nov. 6	1,748,300	30	·86	53,000	42

TABLE C.

	This disease.	Rickets.	Infantile Scurvy.	Cong. Syph.
Hæmoglobin	37 per cent.	44 per cent.	34 per cent.	76 per cent.
Red corpuscles	2,900,000	4,364,000	3,255,000	4,224,000
White corpuscles	24,100	11,000	11,200	13,500
Polymorphonuclear	44·6 per cent.	49·2 per cent.	67 per cent.	51·5 per cent.
Lymphocytes }	46·2 „	4·68 „	27·7 „	40·3 „
Large mononuclears }		3·3 „	4·3 „	6·3 „
Eosinophiles	2·6 „	·5 „	·6 „	·4 „
Myelocytes	5·7 „	0 „	Very occasional	·5 „
Nucleated red cells	Constantly present, often in large numbers. Megaloblasts a striking feature	Occasional	„	0
	—	5 counts	6 counts	2 counts

B—*continued.*

Lympho-cytes.	Large mono-nuclear.	Eosino-philes.	Myelo-cytes.	
Per cent.	Per cent.	Per cent.	Per cent.	
—	—	—	—	
—	—	—	—	—
—	—	—	—	—
—	—	—	—	—
—	—	—	—	—
48·4	8·6	—	3·5	Very many nucleated reds.
—	—	—	—	—
—	—	—	—	—
16	11	4	5	A few nucleated reds.
31·8	13·1	—	13·8	Very many nucleated reds.
39·2	10·8	2·6	5·5	Many nucleated reds.
34·5	10	2·5	7·5	3850 p.c.m.
41	5	3·5	5·5	4200 „
22	9	9	6	750 „
44	9	3	2·5	1272 p.c.m.

DISCUSSION.

Dr. R. HUTCHISON said that he wished he was as certain as Dr. Drysdale and Dr. Thursfield seemed to be that the disease was *sui generis*. He doubted if they were justified in regarding the disease as a definite entity whilst the pathology remained so uncertain. The changes in the blood could not be regarded as forming a feature distinctive of this disease, for in severe rickets and in severe congenital syphilis changes in the blood were met with, which approximated closely to the condition found in this disease, and it was impossible to mark off the disease so sharply as Dr. Drysdale and Dr. Thursfield made out. He thought that the anæmia was probably due to insufficient and incorrect feeding, and the rickets, which not infrequently accompanied the disease, was due to the same cause. He next dealt with the relation of this disease to true leukæmia, and stated that, in his opinion, there were not more than two or three cases reported of true myelogenous leukæmia in children below the age of two years. He said that there was nothing characteristic in the morbid anatomy, and exactly similar changes were found in the organs in fatal cases of rickets. Even the bone marrow presented no characteristic change. He was of opinion that this disease might be a secondary anæmia, possibly due to some specific cause, which had yet to be discovered.

Dr. E. P. BAUMANN said that on the main issue, namely, the question of the existence of this disease as an entity, he was in complete agreement with the view put forward in the paper. In other points, however, he differed from some of the conclusions. In the first place, he was of opinion that the title anæmia pseudo-leukæmica infantum was cumbersome and unnecessary. Pseudo-leukæmia was the term by which Hodgkin's disease was commonly known abroad. Now there was no apparent connection between Hodgkin's disease and the disease under discussion. Nor did this disease resemble very closely the condition of leukæmia. He was therefore inclined to adhere to the simple name of splenic anæmia of infants. He was surprised at the number of cases of recovery (from 60 to 70 per cent. according to the table). Of seven cases which he had had the opportunity of observing during the last two years at the Hospital for Sick Children, Great Ormond Street, six patients died in hospital, and one went out improved. Among out-patients, where the cases would not all be severe, the

mortality would doubtless be lower. Nevertheless, allowing for this he still believed the disease to be a very fatal one. Turning to the consideration of the condition of the blood, Dr. Drysdale and Dr. Thursfield obtained an average leucocyte count of 24,100, and their table showed figures reaching in some instances to more than 50,000 leucocytes per cubic millimetre. In his own case an average of from 12,000 to 14,000 per cubic millimetre was present. The largest number found in any case was 20,000. Dr. Drysdale and Dr. Thursfield seemed to attach little importance to alterations in the shape and staining reactions of the blood-corpuscles. It had always appeared to him that this alteration in shape formed one of the most striking features of the disease. In some cases the polymorphous character of the blood-corpuscles had been so striking as to simulate pernicious anæmia. As regards the ætiology of the disease he had noted the large incidence of splenic anæmia among the children of Polish Jews. Syphilis existed in a far larger number of his cases than in those reported in the paper. In only one case could a specific taint be definitely excluded; in three cases the existence of syphilis was strongly suggested either by the history or the appearance of the child; while in the remaining cases the patients were obviously suffering from congenital syphilis. The mere fact that mercurial treatment did not cure the splenic anæmia was of no great significance, for it was well recognised that para-syphilitic disease did not generally benefit by anti-syphilitic treatment. The majority of the patients, too, suffered from rickets. He, however, agreed with Dr. Drysdale and Dr. Thursfield that splenic anæmia was a disease *sui generis*, and that it could not be considered to be secondary to any other disease.

Dr. G. Newton Pitt suggested that the condition of the blood was indicative of the amount of the reaction which was in progress against toxic conditions. In the cases reported there were periods in which the leucocytosis varied, and this also would seem therefore to point rather to a process of reaction than to a specific infection. He suggested that the disease was related to splenic anæmia in the adult and also to Banti's disease.

Dr. Norman Moore said that Sir William Jenner had always taught that an enlarged spleen was a common characteristic of rickets, and he thought it probable that the enlargement of the spleen and the rickets were produced by the same cause.

Dr. Drysdale, in reply, said that he considered that the clinical features of the disease, together with the condition of the blood, formed a definite picture, which entitled the disease to be regarded as an entity. He did not consider syphilis as a cause of the disease. Syphilis was present in a certain number of cases, but in others it could be definitely excluded. He did

not think that the disease in any way resembled splenic anæmia of the adult.

Dr. THURSFIELD said that it had never yet been proved that splenic anæmia developed out of any other form of anæmia, and this he considered another point in favour of the view of regarding the disease as a clinical entity.

LEUCOCYTE COUNTS IN EIGHTY-THREE CASES OF APPENDICITIS

THE LIMITATIONS OF LEUCOCYTOSIS AS AN INDICATION FOR LAPAROTOMY

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Introduction.

From the surgical point of view cases of acute appendicitis resolve themselves into three groups, namely, those which require no operative measures during the acute stage, those which need evacuation of pus from a local abscess, and those which require an immediate laparotomy for general peritonitis.

In deciding whether a patient may be safely left for a time without operation, every symptom and sign needs careful attention: the distribution of the pain, whether local or general; the vomiting; the extent of the hyper-

æsthesia; the presence or absence of a swelling; the mobility or the rigidity of the abdominal wall; the distension of the bowel or the reverse; the facies of the patient; the condition of the tongue, whether moist or dry; the character of the respirations; the temperature; and the pulse-rate.

Even, however, when all the above points have been considered, it is sometimes impossible to decide whether or not pus be present, needing to be let out. The patient may seem fit to leave, when shortly afterwards a sudden increase in the pulse-rate, more general tenderness and rigidity, with absence of abdominal respiratory movements, indicate a rupture of an abscess into the general peritoneal cavity. The physician then regrets he had not some further clue leading him to diagnose the presence of pus earlier. On the other hand, most surgeons prefer an acute simple case, without pus, to be left until the inflammation has subsided, and then to perform appendicectomy during convalescence.

It is as such a further clue in diagnosing pus that leucocyte counts have been found serviceable.

General Results.

There are several papers upon the subject, the more interesting of which are mentioned at the end of this monograph; but in many published cases the authors attribute too great an importance to leucocytosis as a sign for operation. A new discovery is apt to attract too much attention to itself, with the result that too much is expected of it. The best way to correct this is to record the finding in a considerable number of cases; and the present paper is a contribution to that record, from eighty-three consecutive cases at Guy's Hospital. It is remarkable what great variability they show.

Before discussing the cases themselves, it cannot be too strongly pointed out that a given leucocytosis in appendicitis is not by itself a definite proof either of pus

or the reverse. Leucocytosis is not a "penny-in-the-slot" sign. A leucocytosis of 25,000 or more may occur in a patient who recovers completely without operation, and pus may need evacuation in a patient whose leucocytes never exceed 15,000. The leucocytosis must be taken into account along with all the other clinical indications. The pulse-rate by itself will not decide whether pus is to be let out or not, neither will the leucocytosis; but just as the pulse-rate is of very great assistance in deciding when an operation should be performed in some cases, so may the leucocytosis be of similar assistance in others. It is one amongst many valuable clinical signs in such conditions, but cannot be regarded as of more importance than the rest.

Many cases of appendicitis are clinically such that, whatever the leucocytes might show, the other signs would indicate the need for operation. Others, on the other hand, are such that pulse-rate, temperature, abdominal and general conditions leave it still uncertain whether operation should be performed or not.

Earlier observers held that the absolute leucocyte count was all-important. For instance, Wassermann (9) and Da Costa (5) both conclude that pus is always present when the leucocytes exceed 20,000. This is certainly not so, or at least the patient sometimes recovers without operation even when the leucocytes exceed 30,000 (Cases 21, 43, 44). Cazin and Gros (2) lay much more stress upon a rising leucocyte count, and give the following examples:

No pus.			Pus found.
25,800	...	...	8,350
26,600	...	...	10,200
24,000	...	...	26,250
16,400	...	...	29,000
8,000	...	...	34,000
—	...	...	39,000

A leucocyte count rising with pus accumulation is well

exemplified by Case 66, and several others also show it; whereas none of those patients in whom no pus was present showed a similar continued rise. Yet it cannot be laid down as an infallible rule that "when pus is present there is a rising count," for pus may be present with a falling count, as in Case 60, or with one which remains almost stationary, as in Case 73. A good example of a falling count indicating resolution, though the symptoms were for a time grave, is Case 81. One can only say that a rising leucocytosis is a sign that pus is probably present, and that it seems to have a greater diagnostic value than the mere magnitude of the total count.

Four Clinical Groups.

With a view to laying still greater stress upon the great variability in leucocytosis in appendicular conditions which appear otherwise quite similar, the present eighty-three cases have been classed into the four following groups:

Leucotyte Changes in Each.

Group I.

In these cases the onset was variable, sometimes sudden, sometimes gradual; vomiting usually occurred during the first twenty-four hours, but seldom after; there was usually constipation; the signs were all local to the right iliac fossa, with pain, hyperæsthesia, possibly rigidity; but without tumour. The patients all became convalescent without operation.

In three of these (Cases 11, 15, and 19) an operation during convalescence showed adhesions round the appendix, without pus. In the remainder no operation was performed, and therefore no proof that pus was absent can be adduced. They became quite well apparently, and no operation was needed.

In most of them there was little or no leucocytosis. In

more than two-thirds the leucocytes did not exceed 15,000, and this is what one would expect. But in three cases the leucocytes exceeded 20,000, in one even reaching 31,000, without any other clinical evidence of pus. This is contrary to expectation, but is an important point, showing, as it does, that the total leucocyte count must be very high before it, by itself, can be regarded as an absolute indication for operation.

Group II.

In these cases the clinical signs were again local, and similar to those of Group I, but with this difference: a definite tumour could be felt in all of them. In many of these the question of operation was frequently discussed, but in all there was spontaneous resolution of the swelling.

In this group again it is not possible to say absolutely that no pus was present. In Cases 31 and 32 an operation was performed after convalescence, and adhesions round the appendix, without pus, were found. In the remainder no operation was performed. In some there may have been an abscess which ruptured into the bowel, but, as far as possible, those cases in which rapid subsidence of a tumour suggested the rupture of an abscess into the colon have been excluded from this group, and included in the next. It is possible that appendicular pus may be spontaneously absorbed, as is known to be the case occasionally with empyemata; and this may have happened in some of these patients. But the point is that spontaneous resolution of the tumour, without clinical evidence of the presence of pus, occurred in all, and in none was there an operation during the acute stage.

Again there are the greatest variations in the leucocytes. The maximum (31,000) and the minimum (8,300) are almost identical with those in the first group. In more than a third the leucocytes exceeded 20,000, in one case reaching 31,000, and yet no operation was called for. It is noteworthy that where successive counts were made

the numbers fell in all cases except No. 38, where there is a possibility that an abscess was present at first, but spontaneously ruptured into the bowel.

Group III.

In these patients the signs were again all local to the right iliac fossa, as in the two previous groups; and there was a definite tumour. The difference between these and the cases in Group II is that pus was proved to be present, either by its evacuation at an operation, or by the sudden disappearance of a large tumour, clinically suggesting rupture of an abscess into the bowel.

It will be seen that in a quarter of these cases there was nothing that could be called a leucocytosis at all. In three quarters the figures did not exceed the maximum found in Groups I and II. In the remaining quarter there was so great a rise (34,000 to 56,000) that any case amongst the first two groups is quite eclipsed. If any rule could be laid down as to the minimum leucocytosis which, on one count, indicates pus with any certainty, the figure could not be less than 35,000; and when statistics from other hospitals are published it may prove to be higher still.

On the other hand, as has been already pointed out, it is from cases in this group that the value of a "rising" leucocyte count may be gathered. Case 66 is a good example; Cases 64, 65, and 68 are others, no similar cases occurring amongst Groups I and II. Unfortunately, all the earlier cases were observed before this point was realised; more evidence is needed, and in due course more cases will be recorded. Case 65 is particularly interesting, in that it shows a fall after the appendicular pus was evacuated, and then a rise again as an empyema was collecting. It was the rise which was important here, not the absolute count, which was small.

It has been stated that no increase of leucocytes occurs when pus is enclosed in an old, thick-walled abscess

cavity. This seems not improbable, but there is no means of drawing definite conclusions on this point from the present cases. All that can be said is that chronicity is by no means a bar to leucocytosis. In Cases 53 and 54 the patient had been ill more than a month, and yet there was a leucocytosis. Naturally it will be urged that pus had not perhaps been present all the time. That is quite possible, and the condition of the abscess-wall has not been recorded.

Case 70 is of interest, being particularly difficult to diagnose. In the first place the trouble was in the *left* iliac fossa, the cæcum being transposed to that side; and secondly, the abscess cavity was resonant owing to gas produced by the *Bacillus coli communis*. Neither pulse nor temperature nor general condition made it certain that pus was present, but the leucocytes were 56,750, and helped to turn the scale in favour of operation.

Group IV.

These were cases of appendicitis with general peritonitis; the appendix was either primarily gangrenous, or was bathed in an abscess which had burst into the peritoneum. The signs were no longer local to the right iliac fossa, but general all over the abdomen. All the patients were operated upon; half died, half were cured. Some of the cases were obvious, others less easy of diagnosis. It is well known how deceptive the signs may be owing to absence of pain or tenderness, to absence of a clear history pointing to the primary seat of the mischief, or to the possibility of symptoms being masked by opium given to relieve some previous pain.

Few patients belonging to this group have had their leucocytes counted. Most come into the hospital so obviously ill that laparotomy is performed at once. Of those cases which have been counted, half show 30,000 leucocytes or more. This is higher than the figures usually obtained; more often there is no leucocytosis, as in

the remaining half, and this is usually attributed to the virulence of the infection. Leucocytosis is thought to depend on chemiotaxis; perhaps in a mild case there is a small dose of toxin, the chemiotactic effect on the leucocytes is slight, and they do not increase; in a severe case there may be a large dose of toxin, the chemiotactic effect may be greater, and the leucocytes increase; the dose of toxin may apparently be great enough, even with non-purulent inflammation of the appendix, to cause a leucocytosis; and finally, it seems that a very virulent toxin, as in a bad case of acute appendicitis, may prevent the leucocytes from increasing at all. Perhaps the number of leucocytes may thus afford a measure of the virulence of an attack, or of the lack of reacting-power in the patient; but this is theoretical.

As a diagnostic sign of acute peritonitis the leucocytes are not to be relied upon. In this respect they may be compared to the temperature, which may be up, or may be down, or may be normal. In diagnosing general peritonitis far more stress must be laid upon the pulse-rate, the persistent sickness, the abdominal rigidity and immobility, and the facies Hippocratica, than upon either the leucocytes or the temperature.

Odd Cases.

Without making a fifth group a few additional cases have been placed by themselves because they did not coincide with any of the four main groups.

In four of these (Cases 77 to 80). suppurative pylephlebitis was present, but was not diagnosed during life. In one only was the leucocytosis marked.

Cases 82 and 83 are examples of difficulties in diagnosing pus; the former, because it lay behind the cæcum, the latter, because the trouble began in the left iliac fossa instead of in the right, the cæcum being transposed. In each of these the leucocytes reached 25,000, suggesting, but by no means proving, pus.

Sex and Age.

It might be thought that sex or age might have some definite influence on the leucocytosis. None such can be deduced from an examination of the eighty-three cases as a whole, though it is a curious coincidence that the maximum counts in each of the groups occurred in males.

Comparison with the Results of Others.

A very full analysis of a similar group of cases has been published by Da Costa (5) in America, and it is interesting to compare his results with ours. The following is his table for 118 cases:

Da Costa's Summary.

Leucocytes.	Simple cases.		All pus cases.	
	Acute.	Chronic.	Acute.	Chronic.
Over 50,000	—	—	1	—
40,000 to 50,000	—	—	0	—
35,000 to 40,000	—	—	2	—
30,000 to 35,000	—	—	0	—
25,000 to 30,000	—	—	3	—
20,000 to 25,000	—	—	14	—
15,000 to 20,000	4	—	30	—
10,000 to 15,000	2	9	19	3
5,000 to 10,000	8	9	7	1
Below 5,000	4	2	—	—
Highest	17,000	15,000	58,500	14,600
Average	9,124	9,190	17,718	8,800
Lowest	1,600	2,400	6,000	12,425

The following is a similar table for the present eighty-three cases:

Cases observed by the Author.

Leucocytes.	Clinically no pus.		Pus present.		General peritonitis.
	Acute (under 1 week).	Chronic (over 1 week).	Acute (under 1 week).	Chronic (over 1 week).	
Over 50,000	—	—	—	1	—
40,000 to 50,000	—	—	1	1	1
35,000 to 40,000	—	—	2	1	1
30,000 to 35,000	2	1	—	1	—
25,000 to 30,000	1	3	1	2	1
20,000 to 25,000	3	5	1	4	2
15,000 to 20,000	3	1	2	4	1
10,000 to 15,000	10	5	3	1	4
5,000 to 10,000	5	6	1	1	1
Below 5,000	—	—	—	—	—
Total cases	24	21	11	16	11
Highest	31,000	31,600	49,000	56,750	41,000
Average	14,165	16,885	23,068	25,739	20,608
Lowest	6,875	8,300	7,500	9,500	7,128

It will be seen that whereas Da Costa concludes any leucocyte increase to over 20,000 to mean pus, the author cannot draw the same conclusion from less than 32,000 leucocytes.

The maximum, the minimum, and the average of the author's "simple" cases are all greater than are those of Da Costa's.

The maximum and the mimimum of the cases with pus are similar in the two tables; but the average is higher in the author's cases than it is in Da Costa's. The latter, however, includes his acute peritonitis cases along with those where the pus was local, a fact which would probably bring down the average of his leucoyte counts.

The Differential Leucocyte Count.

It has been suggested that a differential leucocyte count accompanying the count of total leucocytes may afford

further valuable means of diagnosing latent pus. In purulent affections there is said to be a relative increase of the polymorphonucleated cells to 85 per cent. or even 90 per cent., in place of the normal 65 per cent. Unfortunately this investigation was not carried out in the present instance, except in Case 81. Here the polymorphonucleated cells reached 86 per cent., but the patient got quite well without an operation. Pus, if present at all, must have been absorbed, or have ruptured into the bowel, and there was no proof of either.

Da Costa (5) states that he made differential leucocyte counts on several cases, but found them useless. Longridge (8) on the other hand, publishing twenty cases from St. George's Hospital, gives differential counts in which polymorphonucleated cells were over 80 per cent. when pus was present, and were usually under 60 per cent. when pus was absent. Further investigation is needed on this point.

Diagnosis from other Conditions.

The present paper has dealt exclusively with leucocyte counts in cases where appendicitis is the certain diagnosis. There is another aspect of the question, however. The leucocytes may assist the diagnosis of appendicitis from other things. Without enlarging upon this, mention may be made of cases of appendicitis simulating typhoid fever with abdominal symptoms. At least a few cases of appendicitis have presented symptoms so obscure that typhoid fever has been diagnosed. But in the latter the leucocytes are rather diminished than increased; a leucocytosis of 15,000 has before now served to exclude typhoid fever and suggest appendicitis.

In cases of intestinal strangulation, it is said, there is little or no leucocytosis. Not infrequently difficulties of diagnosis between obstruction and appendicitis have arisen; in such cases, the leucocytes may help to solve the difficulty.

To Conclude.

The value of leucocytosis in relegating a given case of appendicitis to its proper group, and in deciding whether an operation should be performed or not, is apt to be overrated. Its value, judged from the present cases, is even less than that deduced by other recent observers from the figures they have found. Many cases with 20,000 leucocytes have resolved spontaneously; many cases with 15,000 or less have had pus present. At the same time leucocyte counts have afforded valuable evidence in certain cases. In no case where the leucocytes have reached 35,000 has pus been absent. A rising leucocyte count is of more importance than is the absolute number. Above all, leucocytosis is to be regarded as only one clinical sign amongst many. By itself it may mislead, but taken in conjunction with the pulse-rate, the temperature and the general condition of the patient, it is an additional sign which may be most valuable in the diagnosis of a difficult case.

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GROUP I.—*Signs local; no tumour; recovery without operation.*

No. of case.	Sex.	Age.	Days since onset.	Pulse.	Temperature.	Leucocytes.	Remarks.
1	F.	30	6	72	98·4	6,875	Uneventful recovery.
2	M.	13	3	76	99·0	7,890	Uneventful recovery.
3	M.	14	9	116	101·6	8,437	
			10	104	101·0		
			11	72	98·4	—	Uneventful recovery.
4	F.	15	8	80	99·2	8,500	Rapidly well.
5	M.	22	4	68	99·4	8,937	Uneventful recovery.
6	M.	20	9	66	98·6	4,600	
			11	56	98·8	9,500	Uneventful recovery.
7	F.	16	2	120	100·0		
			3	85	98·4	10,781	Uneventful recovery.
8	F.	17	7	112	101·0	11,000	
			8	100	100·2	—	Delayed resolution.
9	M.	21	1	112	100·2		
			2	92	99·8	11,000	Uneventful recovery.
10	M.	14	6	92	102·2	11,875	Temperature not down for 4 days.
			7	97	100·8		
11	F.	12	7	132	100·4	—	Operated on during convalescence; adhesions found; no pus.
			8	92	99·8	12,175	

No. of case.	Sex.	Age.	Days since onset.	Pulse.	Temperature.	Leucocytes.	Remarks.
12	M.	17	3	62	98·8	12,500	Uneventful recovery.
13	M.	20	2	100	100·0	12,500	Second attack.
			3	80	99·0	—	Uneventful recovery.
14	M.	13	1	100	100·0	13,000	
			2	80	98·0	—	Rapidly well.
15	F.	17	4	120	100·4	13,500	Operated on during convalescence; adhesions found; no pus.
			6	80	98·4		
16	M.	27	4	80	100·0	14,375	
			5	72	98·8	16,562	
			6	60	99·2	13,438	
			7	64	100·0	14,375	Operation discussed; not done.
			8	64	98·0	13,750	
			9	64	98·6	13,437	
			10	76	99·6	12,812	Uneventful recovery.
17	M.	39	4	92	100·4	16,800	Temperature not down for a week.
			5	98	101·0	—	Uneventful recovery.
18	M.	18	2	96	101·0	18,200	Did not resolve for 10 days; then complete recovery.
			3	102	101·4		
19	F.	17	5	118	102·2	22,500	Sixth attack; operated on during convalescence; adhesions found; no pus.
			6	120	104·0		
			9	76	98·4	6,400	
20	M.	11	12	104	103·0	23,000	
			13	68	98·0		Rapidly well.
21	M.	36	1	96	101·4	31,000	Very diffuse pain.
			2	100	100·2		Got perfectly well, but slowly.
			3	92	99·0		

GROUP II.—*Signs local; definite tumour; recovery without operation.*

No. of case.	Sex.	Age.	Days since onset.	Pulse.	Temperature.	Leucocytes.	Remarks.
22	F.	18	23	104	97·6	8,300	
			24	80	99·0	—	Tumour not resolved for 2 weeks longer.
23	M.	9	10	88	98·0	8,500	Tumour resolved in 4 days.
24	F.	31	6	96	99·2	8,906	Tumour not quite gone till 16th day.
25	M.	42	19	80	98·4	9,062	Tumour not gone till 27th day.
26	M.	26	7	60	98·2	9,580	Rapid resolution.
27	F.	19	7	88	99·2	10,000	
			20	92	99·8	5,312	Small lump still palpable on discharge.

No. of case.	Sex.	Age.	Days since onset.	Pulse.	Temperature.	Leucocytes.	Remarks.
28	F.	19	15	80	97·4	11,000	Already getting better when seen.
29	F.	6	28	84	100·2	11,000	
			29	80	98·2	—	Uneventful recovery.
30	M.	18	13	72	98·4	11,384	Tumour slowly disappeared.
31	M.	29	14	92	98·6	12,800	Operated on during convalescence; adhesions found; no pus.
32	F.	23	2	84	98·8	15,000	Operated on during convalescence; adhesions found; no pus.
33	F.	48	10	112	102·6	12,500	Large tumour.
			11	104	103·6	14,750	Tumour unaltered.
			12	104	103·4	—	Tumour unaltered.
			15	96	98·6	15,600	Operation decided against.
			20	68	96·4	12,000	Tumour gone; uneventful recovery.
34	M.	30	8	64	98·0	20,625	Complete recovery.
35	M.	12	?	88	99·0	20,987	Complete recovery.
36	M.	17	5	108	100·0	21,500	Large tumour.
			6	90	100·4	18,720	Tumour less.
			11	80	97·8	19,475	Tumour less; still present.
			27	72	98·0	7,600	Complete recovery.
37	M.	23	13	60	98·2	22,000	Lump known to have been present 10 days; slow but complete recovery.
38	M.	13	10	106	102·0	19,180	
			11	96	102·0	24,375	Rapid subsidence of tumour;
			12	74	98·4	9,400	? rupture of abscess into bowel; recovery.
39	M.	40	3	80	101·4	25,625	
			4	64	99·2	—	Rapid recovery.
40	M.	11	10	94	99·0	26,000	Apparent complete resolution; did leucocytosis indicate latent pus?
			16	80	98·4	27,000	
41	F.	16	10	88	101·6	28,750	Operation much discussed; not done.
			11	86	100·4		
			12	88	101·6	—	Temperature still up several days; tumour slowly resolved; recovery.
42	M.	42	19	62	100·2	30,000	Large tumour; increased for 5 days; operation often discussed; decided against; tumour shrank from 28th day; gone on 41st day.
			22	72	101·6	18,668	
			23	74	101·0	—	
			26	48	98·4	13,750	
43	M.	9	4	100	101·0	30,625	Large tumour.
			6	96	99·0	22,395	Tumour gradually resolved in 5 days.
44	M.	12	28	96	99·0	31,600	
			30	80	98·4	18,750	Very delayed convalescence; recovery without operation.

GROUP III.—*Signs local; definite tumour; pus let out, in most cases by operation, in four by rupture into bowel.*

No. of case.	Sex.	Age.	Days since onset.	Pulse.	Temperature.	Leucocytes.	Remarks.
45	M.	12	6	104	102·2	7,500	
			7	88	98·6	—	Operation; copious pus.
46	M.	14	11	120	101·4	9,500	
			12	120	101·8	—	Operation; pus found.
47	M.	31	4	68	99·6	12,000	Operation; pus found.
48	M.	11	5	108	103·0	10,000	
			6	100	98·4	12,000	
			8	130	100·2	—	Operation; pus found.
49	M.	11	3	120	104·4	12,500	
			4	100	99·4	—	Operation; pus found.
50	M.	41	16	96	100·0	12,500	
			17	88	101·6	12,500	Operation; pus found.
51	F.	47	8	78	98·4	10,200	Large tumour.
			15	100	101·6		
			16	112	101·6	—	Tumour bigger.
			17	108	99·6		
			18	108	101·6	15,437	Operation; pus found.
52	F.	19	2	114	102·0	15,670	
			3	108	101·2	—	Operation; pus found.
53	M.	27	31	76	101·0	17,062	Operation; pus from cæcum to kidney.
54	M.	10	40	112	98·6	19,062	Operation; pus found.
55	M.	8	9	96	99·0	20,000	
			10	90	98·4	—	Operation; pus found.
56	M.	24	7	96	101·2	20,000	
			8	100	103·4	19,300	
			9	100	102·8	—	Operation; pus found.
57	M.	17	14	104	101·0	20,200	
			15	104	102·2		
			16	73	99·2	19,800	Rupture abscess into cæcum.
			17	62	98·6	5,000	Spontaneous recovery.
58	F.	21	4	124	101·4	21,000	
			5	100	100·6	—	Operation; pus found.
59	M.	45	3	108	99·0	17,000	Large tumour.
			4	100	99·0	21,000	Operation refused by patient.
			6	84	99·0	17,000	
			9	88	99·0	19,000	
			11	104	101·0	23,000	Operation refused by patient.
			12	100	100·0	21,000	Sudden rupture abscess into bowel.
			13	96	98·4	17,000	Spontaneous recovery.
60	M.	39	10	96	99·4	23,000	
			11	98	101·6	19,000	
			12	112	101·4	16,800	
			13	120	100·4	18,750	
			14	100	100·2	18,000	Operation; pus let out.
			16	72	98·4	13,470	
			17	72	98·4	16,400	
			18	68	98·0	7,500	Rapid recovery.

No. of case.	Sex.	Age.	Days since onset.	Pulse.	Temperature.	Leucocytes.	Remarks.
61	M.	11	3	130	97·6	26,000	Operation; pus found.
62	M.	52	14	104	100·0	26,250	Operation; pus let out.
			15	100	99·0	25,687	
			16	96	99·0	21,250	
			19	104	98·4	21,250	
			21	92	98·4	10,000	Uneventful recovery.
63	F.	22	12	100	101·0	14,000	Large tumour.
			21	84	100·4	30,000	Tumour persistent.
			25	108	100·4	—	Operation; pus found.
64	M.	21	7	88	101·6	21,600	
			8	100	101·8	34,062	Operation; pus let out.
			16	80	98·4	14,400	Fæcal fistula.
			21	80	98·4	14,400	
			22	80	98·4	7,000	Slow but complete recovery.
65	M.	32	10	112	101·0	38,000	
			11	134	101·0	32,500	Operation; pus let out.
			12	134	101·0	31,760	
			14	112	101·0	20,938	Rub first heard in chest.
			19	118	101·0	10,937	Extensive pleurisy.
			25	120	101·0	13,281	? Empyema.
			36	130	102·0	15,625	Empyema drained.
			49	70	98·4	8,912	Getting rapidly well.
66	M.	12	2	75	100·2	7,800	
			3	76	99·2	9,062	
			4	72	98·6	11,875	
			7	80	100·6	38,700	Operation; pus let out.
67	M.	6	6	112	97·0	39,375	
			7	96	96·6	—	Sudden disappearance of large tumour; ruptured into cæcum.
68	F.	14	10	96	100·2	18,000	Large tumour.
			14	104	99·0	42,000	Tumour larger.
			15	80	99·0	22,000	Sudden disappearance of tumour; ruptured into cæcum.
			16	80	98·4	7,000	
69	F.	14	4	124	101·6	49,000	
			5	128	99·8	21,000	Operation; pus let out.
			19	100	100·8	—	Temperature not down for over a fortnight; complete but slow recovery.
			22	96	98·8		
70	M.	24	15	100	100·8	56,750	In this case the cæcum was in the *left* iliac fossa, and the abscess contained gas and was resonant.
			21	92	99·8	—	Operation; pus let out.
			26	80	98·4	18,437	

GROUP IV.—*Appendicitis with General Peritonitis.*

No. of case.	Sex.	Age.	Days since onset.	Pulse.	Temperature.	Leucocytes.	Remarks.
71	M.	14	1	128	102·4	7,128	Laparotomy; general peritonitis; slow but complete recovery.
72	M.	12	4	130	102·0	10,625	DIED the same night.
73	F.	17	2	136	102·0	10,800	In consultation, reported "not dangerous."
			4	100	100·0	8,125	Thought to be a little better.
			6	102	100·0	7,500	
			14	90	101·0	8,437	In consultation, still thought operation not indicated.
			17	118	101·0	10,625	Operation; suppurative peritonitis.
			22	180	105·4	—	Patient DIED.
74	M.	11	Same day	144	103·6	30,000	Laparotomy; general peritonitis; cured.
75	M.	16	1	122	100·6	20,000	In consultation, decided not necessary to operate.
			2	104	100·6	17,000	
			3	100	99·8	19,500	
			7	110	101·0	—	Laparotomy; suppurative peritonitis.
			9	154	101·8	31,500	Worse; pus under diaphragm.
			13	?	100·4	37,500	DEATH; pus all over peritoneum.
76	M.	8	9	124	100·4	39,687	No great rigidity; doubtful whether to operate; laparotomy showed acute general peritonitis, and cæcum in *left* iliac fossa.
			10	130	100·4	41,000	
			11	80	99·4	9,312	Rapid recovery.

Seven cases not belonging strictly to any of the four preceding groups.

No. of case.	Sex.	Age.	Days since onset.	Pulse.	Temperature.	Leucocytes.	Remarks.
77	F.	28	6	124	102·4	10,500	Appendicitis and suppurative pylephlebitis, not diagnosed till autopsy.
78	M	23	35	60	95·0	12,154	Gangrenous appendicitis and suppurative pylephlebitis, not diagnosed till autopsy.
79	M.	19	27	112	104·6	24,000	A very obscure diagnosis; all sorts of things suggested; at autopsy an inflamed appendix and suppurative pylephlebitis were found.
			29	112	105·0	23,000	
			44	110	102·0	20,100	
			58	114	103·0	20,625	
80	M.	22	19	140	104·0	18,000	No diagnosis till autopsy; gangrenous appendicitis, general peritonitis, and suppurative pylephlebitis then found.
			20	124	100·4	16,000	
			23	180	100·0	—	
81	M.	30	4	112	102·8	23,800	Symptoms all suggested general peritonitis secondary to an abscess; but patient recovered completely without operation.
			5	120	102·0	17,700	
			7	100	100·6	13,300	
			9	116	101·2	13,432	
			11	100	100·0	8,755	
			12	100	100·0	11,400	*Differential leucocyte count*:— Small lymphocytes, 8·0 per cent.; large lymphocytes, 5·0 per cent.; polymorphonucleated, 86·5 per cent.; eosinophiles, 0·5 per cent.
			14	90	98·4	6,500	
			15	92	98·4	8,300	
82	F.	20	13	108	100·8	25,000	Clinically seemed to belong to Group I, local without tumour; but operation 13th day evacuated much pus from behind cæcum; good recovery.
			16	84	98·4	10,000	
83	M.	23	7	92	101·2	25,000	Clinically a mild case, with no rigidity or pain; operation postponed to 10th day; died same night, general suppurative peritonitis being present. The previous pain had all been on the *left* side, and the cæcum was found transposed to this side.

Method.

In all cases a Thoma-Zeiss Hæmocytometer was used, with the special leucocyte pipette. Blood was obtained from the lobule of the ear, and was diluted 1 in 20 with Thoma's fluid. The contents of the pipette were well mixed; the first half was then expelled; the next droplet was placed in the counting chamber and counted at once.

The leucocytes in the sixteen "big" squares were counted, those cells overlapping the bottom and left hand boundary lines of each big square being omitted, but those overlapping the top and right hand boundary lines being counted in.

One count only was made from each sample; it is found that successive drops from the same mixture are apt to give ascending counts.

In many cases a second drop of blood was taken and a separate count done; in which case the average of the two counts was struck.

The counting sometimes done by different persons, but always under supervision.

My thanks are due to Dr. Frederick Taylor, to Dr. Hale White, to Dr. Newton Pitt, and to Sir Cooper Perry, who most kindly gave me permission to examine patients under their care in the wards of Guy's Hospital.

DISCUSSION.

Dr. L. S. DUDGEON considered that in cases in which an examination of the leucocytes was indicated, both an enumeration of the leucocytes and a differential count should be made. The gradual increase in the number of cells was most important in diagnosing appendicitis. Even 10,000 or 15,000 was often suggestive along with other signs. Over 30,000 was not by any means conclusive as to the presence of pus. The differential count was of great importance. In suppuration 80 per cent. or 90 per cent. of polymorphonuclear neutrophils were often found in place of the normal 65 per cent. In one case in which pus was present there was only a moderate increase of the number of leucocytes, but there was a percentage of 99 of polymorphonuclear cells. The absence of eosinophils was probably of little importance. Ehrlich's method of staining the blood with a mixture containing iodine (one part), potassium iodide (three parts), distilled water to 100 parts, and gum acacia to form a syrup, which should produce a diffuse coloration of brown or deep-brown granules in the polymorphonuclear cells, had seemed to him a very uncertain method. There was no sign absolutely diagnostic of suppuration, but a leucocyte count of 30,000 with 80 per cent. of polymorphonuclears, or of 15,000 with 90 per cent., made the probability of suppuration very great. The diagnosis of perforation in typhoid was important. A gradual increase in the number of leucocytes had been found in some of the cases. In acute intestinal obstruction he had found over 50,000 leucocytes on three occasions, while Professor Osler had recorded a leucocyte count of 80,000 per c.mm. He asked if Dr. French was quite certain that the gas in the abscess cavity was due to the *Bacillus coli communis*.

Dr. G. NEWTON PITT referred to a case of appendicitis, associated with pylephlebitis, due to *Bacillus pyocyaneus;* in which there was no pyrexia and no leucocytosis.

Dr. FRENCH, in reply, had not found much value in the differential count in diagnosing suppuration. The bacillus present, according to the pathological report, was the colon bacillus. In the two cases of pylephlebitis, described in the paper, without leucocytosis, there was no blue coloration of the pus.

ON THE ELASTICITY OF THE AORTA

BEING A CONTRIBUTION TO THE STUDY OF ARTERIAL SCLEROSIS

BY

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In considering the effects of disease upon arteries, pathologists have hitherto occupied themselves chiefly with morbid anatomy. By the naked eye they have observed the thickening, the yellow colour, the stony deposits, the breaches of surface, and by the microscope the cellular changes, which make up the conditions called endarteritis or periarteritis and atheroma, in their various stages. Less attention has been paid to the physical properties of diseased vessels. Yet after all these are the most important. Blood-vessels are not, like glands, the seat of elaborate chemical change. They are tubes whose first office is simply to convey a continuous stream of blood, and though their muscular cells provide for them a mechanism for regulating local supply, the qualities which allow of free passage and continuity of current, of which the chief is elasticity of the arterial wall, must be held the most important.

It seemed good therefore to us to institute an investi-

gation into this property, and for the present to select one vessel only, the aorta, as the subject of our experiments. We hope at a later date to examine its main branches and still smaller vessels in a similar fashion.

Elasticity.—Physical philosophers define elasticity as that by which bodies resume their original form or volume when the force which altered that form or volume ceases to act. But to physiologists and pathologists it must be allowed to use the word in a somewhat different sense. That the arteries should stretch to receive the heart's output is as important as that they should shrink again during diastole. When we say that the elasticity of the arteries is one of the great forces of the circulation we mean their power to yield, as well as their power to resume their form. Our use of the term is in accordance with the popular, which would call a piece of india-rubber more elastic than a billiard ball, though the latter is in the stricter sense the more elastic of the two.

Our experiments upon the aorta of man record the first of these factors in elasticity, namely, its extensility or power to stretch. Aortas stretched by us with weights up to 200 grammes have, when placed in salt solution for five minutes, returned perfectly to their original form. The exceptions have been so few, and so different, and the loss of elasticity so minute, that they do not require consideration. Practically all aortas return to their original proportions after stretching by 200 grammes or less, and are therefore in the strict sense perfectly elastic. But they vary greatly in their power to stretch, and we beg permission in the rest of this paper to speak of this under the name of elasticity, employing thus a common term in the common way, instead of a word like extensility, whose use is unaccustomed, and whose meaning, since both factors were observed, is too confined.

Previous observations.—A comparatively small amount is recorded in literature upon this subject.

Wertheim ('Ann. de Chim. et de Phys.,' s. 3, vol. xxi, p. 385, 1847) measured the increment of length obtained

by an increasing load applied to bones, muscles, tendons, nerves, arteries, and veins. He found that the two increments did not correspond, as had been the case in his previous experiments with inorganic bodies, but that if a line be drawn having for abscissæ the successive charges, and for ordinates the corresponding increments of length, it is not straight, but forms a curve approaching the hyberbola, the increment of length diminishing as the weight increases.

To this law the bones formed an exception. They obeyed the law of inorganic bodies.

He also observed that the specific gravity of tendons, muscles, and veins diminished, but that that of bones, nerves, and arteries increased with age.

He gives references to Clifton Wintringham and Hales (Alb. ab Haller, 'De partium humani corporis præcipuârum fabricâ et functionibus,' Berne, 1777, tome i, pp. 142 and 244), and to Valentin ('Physiol. de l'homme,' Brunswick, 1844, tome i, p. 34) for previous experiments on the subject.

Polotebnow ('Berl. Kl. Woch.,' 1868, p. 361) records brief observations on the condition of the femoral artery in four cases in which there was hypertrophy of the heart and arterial sclerosis. With weights up to 1000 grammes the sclerotic arteries stretched less, and recoiled less fully, than the natural.

Marey ('Travaux de Laboratoire,' vol. iv, p. 178, 1880) measured the volume curves of the aorta of man and animals under gradual increase of internal pressure. He alone of those who adopt this method mentions the difficulty of closing the mouths of all the small branches of the aorta. He overcame it by inserting within the aorta itself a small bag of very thin india-rubber. The aorta thus became the outer coat of an elastic apparatus, much like the leather coat of a football. He confirms Wertheim's law, and mentions that it will be important to study the human aorta at different ages.

Roy ('Jl. of Physiol.,' London and Cambridge, vol. iii,

p. 125, 1880) experimented on the blood-vessels both of freshly-killed animals and of man. In the case of the former he measured the increase of cubic content under increasing internal pressure; in the case of man he measured the increase of length in strips cut in the longitudinal, and also in others cut in the transverse direction, under an increasing load. His paper is of great interest, and forms much the most important work upon the subject. The curves he obtained from the vessels of healthy animals were double or *f*-shaped, at first convex, and later as pressure increased concave toward the axis. Those which he obtained from man were concave only. He ascribed this difference to the different method employed, the former being curves of volume, the latter of length alone. But he also found that when the animal was diseased the curve of volume was concave throughout. He does not seem to have compared curves of volume and curves of length taken under the same conditions from the vessels of animals, or he would have discovered the real meaning of the difference (see p. 494). He confirmed Wertheim's law, and found besides that in man—

1. The old aorta was less elastic than the young, even though no macroscopic or microscopic difference could be detected.

2. The removal of the intima and adventitia made practically no difference in the curve of the young aorta, though these coats appeared to have more influence in the old.

3. The elasticity of longitudinal strips is much less important than that of strips cut transversely to the length of the vessel.

We owe also to Roy the observations—

4. That "until putrefaction is far advanced the elasticity curve of any artery remains the same. . . . . In experimenting on the elasticity of human arteries, therefore, no error is introduced owing to the interval which

has necessarily elapsed between death and the *post-mortem* examination."

5. That "curves taken very slowly" (occupying, for instance, half an hour as did some of his) "are the same in form as those taken rapidly, *e. g.* in two or three minutes."

Israel ('Virchow's Archiv,' vol. ciii, p. 461, 1886) stretched pieces of the aorta taken from fifty persons of both sexes by means of weights. His strips were 0·5 cm. wide, 6 cm. long, and were cut in the longitudinal direction from the upper and lower thoracic, and from the abdominal aorta, and in the transverse direction from the ascending part of the arch. The close resemblance of the tracings from the first three showed that a single strip is honestly representative, and that what is true of one part of the vessel will be true of the rest of it. He found that the fourth strip, cut transversely, was much more easily stretched, and that this is the case generally with transverse compared with longitudinal strips. He thus confirms Roy's conclusions, but is evidently ignorant of his work. In his fifty cases the least elastic were from a group of drunkards, next came the nephritics, next normal persons, and the most elastic of all were from chlorotic patients; but he gives no details of age or disease, and the paper is not of much assistance in this respect.

Thoma and Kaefer ('Virch. Archiv,' Bd. cxvi, p. 1, 1889) experimented with the human external iliac. They inflated the vessel with air, and measured the increased width of the vessel under different pressures with a telescope. Their apparatus was clumsy in the extreme, and, as is very evident from their description, and from the curves they give, frequently ruptured some part of the vessel wall. Their paper is deprived of most of its pathological value by a curious mistake. Misled by the physical use of the term elasticity, they actually state that they consider those arteries most perfectly elastic which stretch least, and take them for the types of normal. It is a singular instance of the "Idolon Fori" of Bacon.

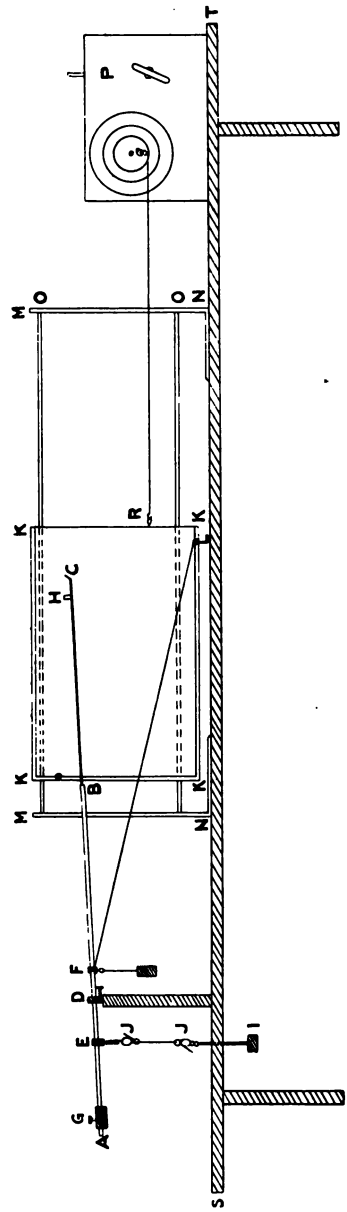
Further, their mixture of the sexes and the fewness of their observations (for out of twenty cases seven are plainly cases of mechanical rupture) render the paper of little real value. They are ignorant of Roy's work, but confirm his statement that vessels taken from man at the usual interval after death are quite trustworthy for experiment.

MacWilliam ('Proc. Roy. Soc.,' vol. lxx, p. 109, 1902), in a paper published while we were in the middle of our work, explains the *f*-shaped curve which Roy obtained from freshly-killed animals. He shows that it is not, as Roy thought, peculiar to curves of volume, but obtains also in curves of length, and that it is entirely due to *post-mortem* rigidity. A vessel wall that is relaxed gives the single concave curve which is produced by the human aorta, and the shape of the curve is, he states, a safe test of the presence or absence of rigidity. This is a valuable observation, since it relieves all such experiments from this source of error. The curve from the human aorta is always concave, and is thus proved to be taken under the same condition of tissue.

The apparatus.—The apparatus used in these experiments for testing the extensility of the strips of aorta was suggested to us by Professor Roy's instrument, but it will be found to differ very materially from his arrangement.

Our apparatus consists essentially in a balanced bar (A, B) 39 cm. long, forming a lever of the first order. On one side of the fulcrum (D) of this lever, which is raised some 15 cm. above the base-board (S, T), at a distance of 5 cm. is fixed a small holder (E) with a few links of chain hanging from it. (This holder, though fixed at 5 cm. distance from the fulcrum throughout our experiments, is capable of being shifted nearer to or further from it if this be considered desirable; 5 cm. was chosen as giving the best results, after several experimental tests at varying distances.)

On the other side of the fulcrum is a sliding carriage (F),


T
P
M
O
O
N
R
K
K
H
C
K
B
K
M
N
D
F
E
J
J
I
G
A
S

hanging from which is a weight of 50 grammes. This carriage is capable of sliding from the fulcrum to a point 24 cm. from it, and the part of the bar (D, B) along which it slides is marked off into centimetre lengths. The portion of the bar (A, D) to which the holder is attached measures 15 cm., and sliding on it is a weight (G) of 53 grammes, which can be clamped at any point and so adjusted as to make the bar, with its extension piece carrying the pen, exactly balance on its fulcrum.

The bar was made of a length of cast steel rod, 5 mm. in diameter, which has the advantage of being a commercial article, and which is accurately straightened and gauged.

To the long end of the bar was fixed a thin, flat, steel bar (B, C) 24 cm. long, which, though rigid vertically, allowed lateral play. To the end of this was attached the glass syphon pen (H) carrying ordinary ink. (The use of such a pen, though fragile, was on the whole convenient, as it allowed us to use ordinary white paper for our diagrams.) The object of this 24 cm. extension-piece was to magnify the excursions of the end of the bar, and at the same time allow a certain amount of play to the point of the pen when this was pressed against the paper.

From the holder-chain was hung the strip of aorta, clipped at each end by small metal clips (J, J), and hooked on above to the chain and below to a ring fastened to the end of a screwed rod (I), which passed through a small sliding plate fixed to the base-board. The object of this arrangement was to enable the ring to be adjusted immediately under the holder in whatever position this might occupy on the rod. As a matter of fact, the holder was always kept at 5 cm. from the fulcrum, and thus the ring always occupied the same position in the base-board. The ring was made to adjust vertically, so that strips of aorta of varying length might be tested, and any form of clip might be used. This adjustment

was also useful, as it allowed the pen to be raised to the top of the paper before the tracing was begun.

The base-board (S, T) which was 1 m. 30 cm. long and 16 cm. wide, carried also two cast-iron brackets (M, N), supporting two horizontal steel rods (O, O), forming guide-bars, which allowed a flat board (K, K, K, K), 28 by 24 cm., to travel horizontally parallel to the long lever. This flat board carried a sheet of highly glazed paper, which was kept flat upon its surface by the edges being passed under narrow wooden strips.

This recording-board was given a range of travel of 24 cm., being drawn along the guide-bars by a thread (R, Q) attached to a (P) clockwork-driven pulley (Q), run at such a speed that the 24 cm. was traversed in 120 seconds.

Finally, from the lower part of the recording-board a thread (F, L) extended to the weight-slide, so that, for every centimetre the board was drawn along, the weight also travelled along the rod an equal distance, and as the weight moved away from the fulcrum the strip of aorta was subjected to a constantly increasing strain; for each centimetre the weight moved along the bar 10 grammes were added to the strain on the aorta.

Originally provision was made for keeping the strip of aorta in a cylinder of oil during the process of stretching, but it was soon found that the strip was exposed to the air for so short a time that practically no drying took place, and this was unnecessary. The main difficulty in arranging this instrument, and a point about it which we consider open to criticism, is that the thread which pulls the weight along the bar does not always pull in the direction of the bar, but at an angle (for instance, on the diagram the angle is BFL about 25°). This angle is greatest at the beginning of the test, and is reduced to 0° when the latter part of the curve of a normal aorta is being traced. Thus that part of the strain which is not parallel to the bar, and which tends to augment the weight, is at a maximum when the leverage is at a

minimum, and is reduced to zero when the leverage becomes serious. In this way we endeavoured as far as possible to minimise this fault.

Another point about the working of the apparatus that requires note is that the sliding carriage must not slide too easily. If it does, when the bar is pointing downwards the weight slides along merely by gravity. On the other hand, the bar must be quite smooth, slightly greasy, and free from dust, otherwise the carriage will move along jerkily, and this will be shown on the diagram.

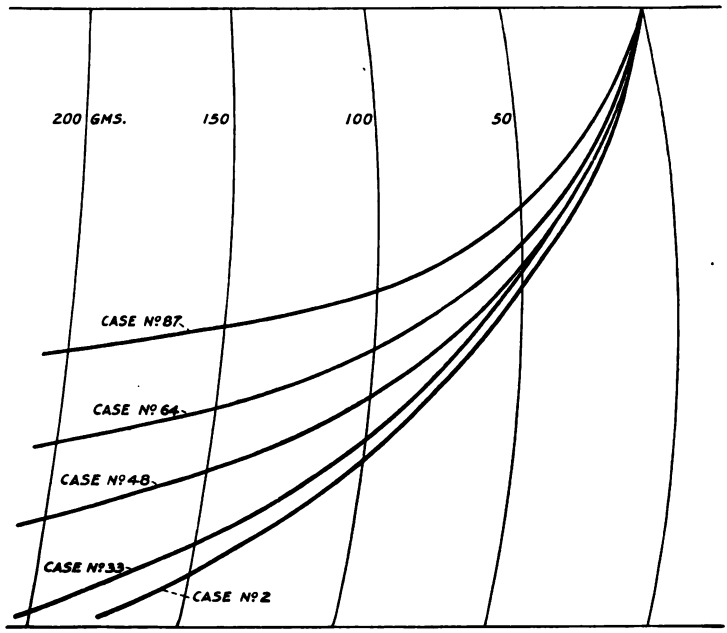
It was necessary for a valid comparison that the portion tested should be of a uniform length and width. We finally selected 4 cm. between the clips as the most suitable length, having regard to the average size of the aorta at all ages. The edges of the clips were made flat, as serrated edges were found to damage the tissue. Each clip was 1 cm. wide to correspond with the width of the strip.

To obtain strips of aorta always exactly of the same width (1 cm.) we used two thin razor-blades fixed parallel in a holder, 1 cm. apart. These, being pressed down on the aorta, opened and laid flat on a piece of cork, cut out a strip of this width and of a width that never varied.

The way the experiment was actually performed was as follows:—A transverse strip was cut out of the aorta, and the clips were then applied. The pen having been attached to the end of the recording lever, and the paper fixed upon the board, one clip was hung to the holder chain. Before the lower clip was attached to the ring below, the lever was carefully balanced by shifting the moving weight G on the short arm of the lever. While this was being done the 5-gramme weight was of course hanging under the fulcrum, and the fulcrum, which had a horizontal adjustment, was so swivelled round that the pen did not touch the paper, and the lever was quite free. The lever being balanced exactly, the lower clip was hooked to the ring at the bottom, and the ring was raised or lowered so that the point of the pen was opposite the

upper part of the paper; the fulcrum was then so swivelled that the pen lightly touched the paper.

The clockwork being now set in motion, the recording board began to travel along its guides away from the fulcrum, drawing with it the sliding carriage and weight;



The curves are traced from cases selected as typical of the various decades.

Those cases have been chosen which approached most nearly to the main curve of the best class of aorta in each decade.

But it will be seen on reference to Table I that the cases do not themselves all belong to the best class.

Case No. 2, age 18, is a "natural" aorta.
" " 33, " 36, is a case of slight atheroma.
" " 48, " 45, is a case of considerable atheroma.
" " 64, " 52, is a case of slight atheroma.
" " 87, " 62, is a case of slight atheroma.

this process was continued until the board had traversed a distance of nearly 24 cm., and the 5-gramme weight had increased its leverage until it represented 200 grammes.

Then the clockwork was stopped, the strain on the aorta removed by raising the lever, and the strip at once unhooked and replaced in salt solution. The whole test did not take more than a few minutes, so that no appreciable drying of the strip took place, and, as already said, the oil bath was unnecessary.

Marks were then made with the pen on the paper with the weight at zero, at 5, 10, 15, and 20 cm. along the bar, so that, at the points on the tracing curve where these lines intersected it, the curve represented the effect of a weight of 0, 50, 100, 150, and 200 grammes. A base line having been already marked upon the paper, the values of the curves at these weights could be recorded in length of the ordinates, and are given in the accompanying tables.

In the case of very elastic arteries we found that the curve ran off the paper with weights of 150 grammes, so that we could not record the effect of 200 grammes. This was due to our having used rather too great a length of lever, producing greater magnification of the stretch than the paper would include. We did not quite realise this until we had done so many tests that we felt disinclined to alter the apparatus. It will be seen that these very elastic arteries practically all belong to young persons. Of course it must be clearly understood that the measurements of the ordinates do not represent the actual elongation of the artery, but the elongation multiplied by about 10, owing to the relative lengths of the two portions of the lever.

Owing to the want of parallelism in the thread pulling the weight and the bar, certain slight errors were introduced into the tracings, which do not in any way vitiate the results we have obtained, because these results are obtained on the same machine, and are therefore accurately comparable with one another, but they prevent the curves from being true mathematical curves, as they otherwise would probably prove to be. Dr. Hensley kindly subjected a number of these curves to mathematical

examination, as they appeared to him to be hyperbolæ, but they did not prove to have the functions of these figures. That is a pity, as it would render the comparison of the tabulated results much simpler and easier of expression.

For purposes of comparative investigation we believe the instrument to give very satisfactory results, though no doubt certain modifications in the method of applying the gradual increase of weight are well worth trial. But the mechanical connection between the moving record-board and the weight has great advantages, as it gets over all difficulties which might otherwise be introduced by relative irregularity in speed of the board and the application of the weight to the aorta.

The part of the aorta selected was that immediately below the termination of the arch. This is the first part of the vessel which, when cut open, will lie flat upon a board, and from which a strip with exactly parallel sides can be obtained. The width of the aorta was measured after the vessel had been cut open.

Results.—We have thus examined the aorta from 100 men and twenty-eight women. The following remarks are drawn from male aortas alone, as we found that the female obeyed the same laws, but was at every age less elastic than the male.

As already stated we selected 4 cm. between the clips as the most suitable length. But this excludes a certain number of young cases. Most men under twenty, many under thirty, and a few over thirty, have an aorta narrower than this requires. We cannot, therefore, put forward the cases given in the first group as fully representative. They are from aortas wider than the average. But this does not much affect the argument. The smallest do not go below 4 cm. (4·3 cm. were required by our apparatus), and as the gradual enlargement of lumen without visible morbid change is, at any rate up to the age of thirty, allowed to be due to natural growth, the vessels which we have used may be taken as giving the natural elasticity

for their class, though the figures will not quite accurately represent the average measurements which would obtain.

Table I gives the details respecting 100 male cases. The columns giving the age, the width and condition of the aorta, the weight and condition of the heart, and the mortal and coincident diseases, represent the various directions in which we have looked for an explanation of the variation in elasticity.

We confess that we began this investigation under the impression that we should find in the aorta an explanation both of cardiac hypertrophy and of arterial sclerosis. One of us had ventured in a paper read before the Pathological Society ("On the Condition of the Renal Arterioles in Chronic Bright's Disease," 'Path. Trans.,' vol. lii, 1901) to suppose that the aorta stiffened before the arterioles, and that the changes which take place in it would be found to explain the cardiac hypertrophy of later life. It was therefore a surprise to us to find that no connection whatever could be traced between the condition of the heart and the elasticity of the aorta. Nor could any such connection be found to exist with the general nutrition of the body (which though not tabulated was in each case noted), or with the diseases, whether mortal or coincident, under which the patient suffered.

We should have been glad to trace especially the influence of syphilis and of the habit of alcoholic excess. But we were dependent upon the patients of others, and it is within the knowledge of all that notes of previous syphilis and alcoholism are, unless special attention be given, very untrustworthy. We feel that these points still remain open.

But apart from all other possible explanations, and overriding all other influences, three facts appear plainly from the figures set out in Table I (see also curves on p. 499).

1. Wertheim's law obtains at all ages. The increment

of length does not vary proportionately with that of weight, but diminishes as the weight increases.

2. The width of the aorta increases from the earliest to the latest decade.

3. The elasticity of the aorta decreases from the earliest to the latest decade.

In Table II the results are averaged. We have tabulated under A the width of the aorta when laid open on the *post-mortem* table, under B the extent to which it yields further to the various loads employed.

The broad results obtained in "all cases" we have further subdivided into three. The first of these represents the aortas in which no thickening, yellow streaks, or advanced atheroma could be seen by the naked eye, the second those vessels in which a slight degree of this change was observed, and the third those in which the changes were more than slight. These morbid appearances signify changes in the intima alone, and may be thought by some to be insignificant. But there is no other easy classification to hand; microscopic investigation affords, as we shall show, none better; and lastly, this has already been adopted by other pathologists as the basis of their analysis.

A. *Width of aorta.*—The aorta becomes wider with age. The average of "all cases" shows that this increase is not evenly distributed. The average width of the aorta is—

In the	twenties	4·645 cm.
„	thirties	5·000 „
„	forties	5·516 „
„	fifties	5·99 „
„	sixties	6·33 „

The increment of width is—

In the	thirties	0·355 cm.
„	forties	0·516 „
„	fifties	0·474 „
„	sixties	0·34 „

The forties therefore show an increment considerably larger than that of any other age.

But this is not characteristic of all subdivisions. "Natural" cases show a different order. They increase—

In the thirties by 0·46 cm. (8 cases)
„ forties „ 0·2 „ (7 „)
„ fifties „ 0·41 „ (4 „)

In the sixties there are no "natural" cases.

Cases "slightly atheromatous" increase—

In the thirties by 0·1 cm. (8 cases)
„ forties „ 0·9 „ (10 „)
„ fifties „ 0·41 „ (5 „)
„ sixties „ 0·34 „ (12 „)

Cases with "much atheroma" increase—

In the thirties by 0·1 cm. (1 case)
„ forties „ 0·66 „ (7 cases)
„ fifties „ 0·41 „ (10 „)
„ sixties „ 0·12 „ (8 „)

It would not be safe to give too much weight to these numbers, since the cases in each subdivision are few. Yet they unmistakably indicate the forties as a time of life when the aorta is apt to yield considerably to the forces of the circulation.

B. *Elasticity.*—The elasticity diminishes with age. That is the broad rule. There are two small exceptions only. Otherwise it obtains for all conditions of the aorta, with all loads.

The exceptions lie in the thirties. "Natural" cases of this period stretch not less but more than younger aortas when light loads are used. With the lightest load (50 grammes) they stretch so much more that they influence the general average. But when 150 grammes are used they already begin to show stiffening, and still more with the heavier load.

The loss of elasticity is not the same at each age interval, nor for each load.

With	50	grammes	the *increase*	in the	thirties	is	0·04
,,	,,	,,	*decrease*	,,	forties	,,	0·91
,,	,,	,,	,,	,,	fifties	,,	0·59
,,	,,	,,	,,	,,	sixties	,,	1·44
,,	100	,,	,,	,,	thirties	,,	0·29
,,	,,	,,	,,	,,	forties	,,	1·93
,,	,,	,,	,,	,,	fifties	,,	1·54
,,	,,	,,	,,	,,	sixties	,,	2·44
,,	150	,,	,,	,,	thirties	,,	0·48
,,	,,	,,	,,	,,	forties	,,	2·8
,,	,,	,,	,,	,,	fifties	,,	2·28
,,	,,	,,	,,	,,	sixties	,,	2·93
,,	200	,,	,,	,,	thirties	,,	?
,,	,,	,,	,,	,,	forties	,,	>2·26
,,	,,	,,	,,	,,	fifties	,,	2·73
,,	,,	,,	,,	,,	sixties	,,	3·22

The age at which the loss of elasticity is greatest is evidently after sixty. This obtains for all loads. But the period which comes next in the general average is that of the forties. For all but the heaviest load there is a greater difference between the forties and the thirties than between the thirties and the twenties or between the fifties and the forties. With the heaviest load the rate of loss advances regularly with age.

Although, however, this is true of the general average of "all cases," it is not true of the "natural" class. A small table will show this clearly.

"Natural" Cases.

Load.	Age. 30—39.	40—49.	50—59.
50 ...	+ 0·51 ...	− 0·52 ...	− 1·09
100 ...	+ 0·33 ...	− 1·47 ...	− 2·06
150 ...	− 0·51 ...	− 2·42 ...	− 2·50
200 ...	— ...	− 2·23 ...	− 2·77

In these cases the loss of elasticity is greater in proportion to age.

The same is also true in the next class except for the higher weights above sixty.

Cases with "Slight Atheroma."

Load.	Age. 30—39.	40—49.	50—59.	60—.
50 ...	− 0·47	− 0·46	− 0·71	− 1·05
100 ...	− 0·60	− 1·22	− 1·90	− 1·98
150 ...	− 1·05	− 1·78	− 3·00	− 2·51
200 ...	—	> − 0·66	− 3·40	− 2·84

The general average has, in fact, been influenced unduly by the cases with severe disease of the intima. It would be safer to omit these if we wish to examine what we must consider a natural tendency; and if they are omitted the broad rule appears to be that each ten years added to a man's life lessens the elasticity of his aorta not equally but in an increasing ratio.

Elasticity therefore not only diminishes, but diminishes *progressively* with age.

Thus it appears that the aorta, becoming wider, loses its original elasticity in the process. Such a change must, we think, be considered passive. It is not easy to see how any disease could actively widen the lumen of the vessel, whereas it would be in accordance with other facts to suppose that the aorta yields gradually to the forces of the circulation, and becoming permanently stretched can stretch but little more. It loses its reserve of elasticity.

The aorta is thus passive under the two forces between which it lies—the heart and the peripheral arteries,—and sclerosis probably affects the aorta as a consequence of their action rather than as a disease originating in it.

We were unable to make out any simple proportionate relation between the increase of width and the loss of elasticity.

Histological changes.—It remains to be seen whether in the vessel wall any changes can be observed which corre-

spond to or explain this loss of elasticity. In the first place, to which coat is it to be referred?

A. *Intima.*—As already stated, Roy by stripping the intima from normal arteries satisfied himself that in health the intima did not determine the elasticity. He believed the media to be if not solely at any rate mainly concerned. It might be otherwise, he thought, in disease. Where atheroma had set in he believed that the intima might possibly play a large part in stiffening the vessel.

In our tables it is evident that in the "natural" subdivision there is at all ages almost the same amount of elasticity as in cases of "slight atheroma." It is not until the last class of severe atheroma is reached that its influence, if it has any, appears; and this influence is not always perceptible. In the twenties, aortas that are atheromatous stretch more than the natural. In the forties, the aortas that are slightly diseased stretch more than the natural with heavy weights.

When the disease is severe the aorta, except in the twenties, is stiffer. But it must be remembered that the stiffening need not on that account be caused by the state of the intima; it may be due to coincident changes in the media.

B. *Adventitia.*—The external coat was similarly tested by Roy, and with similar results.

The following cases illustrate the influence of these two coats upon elasticity. They are not among those in Table I.

Timothy D—, aged 67. Aorta 6·7 cm. wide. Extremely atheromatous, with small calcareous patches. The ordinary tracing was first taken.

(1) Aorta entire stretched with 50 grammes 4·5 cm.
" 100 " 5·5 "
" 150 " 6·1 "
" 200 " 6·5 "

After the usual five minutes' rest in salt solution, during

which the strip returned perfectly to its original length, the intima was removed, and the same strip was again tested.

(2) Same strip after removal of intima—

Stretched with	50	grammes	5·7 cm.
,,	100	,,	7·2 ,,
,,	150	,,	7·8 ,,
,,	200	,,	8·2 ,,

To avoid any error due to previous stretching, a fresh strip was taken and the intima removed.

(3) Fresh strip after removal of intima—

Stretched with	50	grammes	5·7 cm.
,,	100	,,	7·4 ,,
,,	150	,,	8·0 ,,
,,	200	,,	8·6 ,,

James W—, aged 65. Aorta 6·0 cm. wide. Very atheromatous, with one or two small calcareous patches. The ordinary tracing was first taken.

(1) Aorta entire stretched with 50 grammes 4·6 cm.

,,	,,	100	,,	5·6 ,,
,,	,,	150	,,	6·3 ,,
,,	,,	200	,,	6·7 ,,

The strip was placed for five minutes in salt solution, and returned perfectly to its original length. Both intima and adventitia were then removed, and the same strip was again tested.

(2) Same strip after removal of both intima and adventitia—

Stretched with	50	grammes	4·6 cm.
,,	100	,,	5·7 ,,
,,	150	,,	6·4 ,,
,,	200	,,	7·0 ,,

Thomas B—, aged 57. Aorta 5·4 cm. wide, slightly atheromatous.

(1) Aorta entire stretched with 50 grammes 8·0 cm.

,,	,,	100	,,	11·3 ,,
,,	,,	150	,,	12·5 ,,
,,	,,	200	,,	13·6 ,,

The strip was placed five minutes in salt solution, and returned perfectly to its original length. Both intima and adventitia were then removed, and the same strip was again tested.

(2) Same strip after removal of both intima and adventitia—

Stretched with 50 grammes 8·2 cm.
„ 100 „ 11·3 „
„ 150 „ 12·6 „
„ 200 „ 13·6 „

A fresh strip was taken, and both intima and adventitia removed.

(3) Fresh strip after removal of both intima and adventitia—

Stretched with 50 grammes 8·2 cm.
„ 100 „ 11·3 „
„ 150 „ 12·8 „
„ 200 „ 13·7 „

Herbert S—, aged 54. Aorta 5·5 cm. wide, slightly atheromatous.

(1) Aorta entire stretched with 50 grammes 7·1 cm.
„ „ 100 „ 10·3 „
„ „ 150 „ 11·5 „
„ „ 200 „ 12·5 „

With the usual precautions the same strip was tested again.

(2) Same strip after removal of adventitia—

Stretched with 50 grammes 7·8 cm.
„ 100 „ 11·2 „
„ 150 „ 12·8 „
„ 200 „ 13·8 „

Another strip was taken and the adventitia removed.

(3) Second strip after removal of adventitia—

Stretched with 50 grammes 7·3 cm.
„ 100 „ 10·8 „
„ 150 „ 12·4 „
„ 200 „ 13·4 „

From this strip, after the usual interval, the intima was removed.

(4) Second strip after removal of intima as well as of adventitia—

Stretched with	50	grammes	8·2 cm.
„	100	„	12·0 „
„	150	„	13·8 „
„	200	„	14·5 „

These experiments illustrate sufficiently how slight is the influence of intima and adventitia upon the elasticity of the aorta. Neither apart nor together do they approach the media in this respect.

c. *Media.*—It was thus made clear that the chief factor concerned in the stiffening of the aorta lay in the media. This tunic was therefore examined as carefully as possible in 45 cases.

We first measured under the microscope the thickness of the coat, and the results are given in the fourth column of Table III. Everyone is familiar with the thick aorta of later life, and it was therefore to be expected that the measurements of the media should increase in the later decades. We were, however, surprised to find that the change is not throughout life always in this direction.

Under 30	the average thickness of the media is			0·915 mm.
From 30—39	„	„	„	0·944 „
„ 40—49	„	„	„	0·885 „
„ 50—59	„	„	„	1·099 „
Over 60	„	„	„	1·066 „

The explanation seems to us to be as follows:—The expansion of the aorta, which is continuously taking place, tends naturally to make its walls thinner. But this is throughout life opposed by some process of a thickening nature. In the forties the tendency to dilate, which is here at its maximum, altogether overcomes the other, with the result that the wall becomes much thinner. In the fifties the second process, whose exciting cause may perhaps be mechanical or chemical irritation, but whose effect is certainly conservative, gets the upper hand. In the sixties the balance again turns the other way, not this time from an excessive dilatation, but from a failure

of what may be fairly described as a power of compensation.

To what then is this thickening due, and in what tissue does it reside?

We examined first the muscular fibres.

It seemed imperative to begin by forming some idea of their number, and we therefore set to work to do so by counting the nuclei. For this we used an eye-piece micrometer ruled with sixteen squares the sides of each of which were 0·02 mm. in length. A large square with a side of 0·08 mm. was thus formed, the subdivision of which allowed us to count the nuclei with accuracy. Beginning from the inner border of the media we drew the squares across it at right angles, adding up the nuclei contained, and repeating this process ten times we obtained the total number of nuclei in a strip 0·8 mm. wide drawn right across the depth of the media. The sections were cut of a uniform thickness of 0·006 mm. with a Cambridge rocking microtome.[1] This total divided by eight gave us the total number of nuclei in a strip 0·1 mm. wide, and 0·006 mm. thick (Column 5).[2]

Under	30	the average number is		252
From	30 to 39	,,	,,	,, 227
,,	40 to 49	,,	,,	,, 206
,,	50 to 59	,,	,,	,, 167
Over	60	,,	,,	,, 183

This progressive diminution does not, however, imply necessarily that there are fewer cells in the whole aorta, for the aorta is expanding all the while, and at various ages a strip of this width bears a different proportion to the whole vessel. This can be corrected by multiplying, in each case, by the width of the aorta in millimetres. The total, in a complete circular section of the aorta, is thus obtained (Column 7).

[1] This thickness was found to be necessary. Some aortas are very difficult to cut through, and the sections had to be uniform.

[2] The process was often repeated on two or three sections of the same aorta.

When this is done we find that—

Under 30	the average number is			1,180,384
From 30 to 39	„	„	„	1,138,709
„ 40 to 49	„	„	„	1,152,306
„ 50 to 59	„	„	„	1,039,266
Over 60	„	„	„	1,101,910

When we consider how many sources of error unavoidably arise in such calculations, we think that from totals so closely approaching one another the only conclusion to be drawn is that on the whole the muscular fibres of the human aorta do not increase or diminish, but tend to remain of the same number throughout life after twenty years of age.

But, granting this, it is plain that the numbers vary enormously in individuals. In the youngest group the highest number is 1,566,950, the lowest 866,378, a difference of nearly 50 per cent., and the extremes are as far, or further, apart at other ages.

Is such a difference due to disease? The evidence does not support such a view. The difference is as marked in the youngest group as anywhere, and at this age no morbid process can well be supposed at work which would increase muscular tissue. The unusually muscular aortas are from patients who died of various diseases, and with every condition of viscera. The aortas, whether to the naked eye or to microscopic examination, were sometimes natural, sometimes not. Lastly, their elasticity varied just as much as this quality varies in the general run of vessels. No common character could anywhere be found to separate them from the rest. They are in no sense peculiar.

The same is true of those vessels whose muscular tissue is markedly below the average.

It seems to us therefore unreasonable to call that morbid which affords no evidence of disease. We think it wiser to believe that men may vary as well in their internal as in their external muscularity, and that as one man may have a bigger biceps, so may another have a

more muscular aorta, as a natural gift, than his neighbour.

We did not, however, rest content with estimating the number of fibres alone, but made some attempt to examine their size. This is an exceedingly difficult task since it needs a dye which shall stain the cytoplasm, and not the surrounding tisssue. Prolonged treatment (thirty-six hours) with alum carmine after hardening in formic acid and alcohol was found to be the best. It is not a matter susceptible of instrumental measurement since both the length and breadth can be varied almost indefinitely by a slight alteration in the angle at which the cell is cut. But we can confidently say that the size of the muscular fibres is not appreciably altered.

The comparison of different stains assured us also that the enumeration of muscle nuclei was not falsified by the inclusion of connective-tissue nuclei. These are extremely rare, and are for the most part found only where capillaries or minute arterioles run in the layers of the media.

In one or two cases, of which No. 69 is the most marked, there seemed to be some change in the muscle fibres. The nuclei take the stain ill, look glassy or crystalline, and in some places the nucleus and muscle fibre seem to be swollen and homogeneous. This rare condition, even if it be not accidental, which is possible, cannot have much to do with the general loss of elasticity that is so universally found. We could discover no change in nuclei or cytoplasm which we could in any way connect with this.

The condition of the muscular fibres having thus afforded us no clue to the alteration of elasticity we turned to the other elements of the coat, to the elastic laminæ, and to the indefinite connective tissue lying between them.

Dmitrijeff ('Beiträge von Ziegler,' vol. xxii, p. 207, 1897) has described an increase in the elastic tissue of the intima, and also a granular degeneration of the elastic laminæ in the media. The former point has been noticed

by others also, and Jores ('Centralblat. f. Allg. Pathol.' vol. viii, p. 868, 1897, only an abstract, the original paper, if published, not being accessible) has given a description of the ways in which the new fibres arise.

We can corroborate Dmitrijeff's first statement. The thickened intima often contains abundant fine elastic filaments, staining deeply with orcein; but we cannot confirm his second observation, and whether we stained by orcein, or by Herxheimer's method, or by van Giesson's, we have never, in the aorta, been able to verify any changes in the elastic laminæ themselves.[1] The bright elastic lines are always plain, clear, and regular. The only exceptions to this have been two cases of extreme and general aortitis, of which one, in a young soldier, the subject of syphilis, is not included in our lists; the other is No. 90 in Table I. In these two the elastic laminæ and muscular tissue were interrupted by wide areas of newly-formed fibrous tissue.

Coats and Auld ('Journ. of Pathol. and Bacteriol.,' vol. iv, 1896–7, p. 78) also describe this granular degeneration in the shallow pouches which form, in their opinion, the earliest stages of aneurysm. Since all vessels showing such irregularities were rejected by us in our experiments, our observations do not contradict theirs.

Relying on the great resistance to reagents which is ascribed to elastin, we thought it desirable to attempt a quantitative estimation of the elastin in various aortas. A series of chemical analyses was therefore carried out by one of us. The results of this will, however, form the subject of a separate communication. We were unable in this way to throw any light upon the loss of elasticity.

There remained the structureless connective tissue. It seems a necessary consequence that if the bulk of the aortic wall is increased in age, which it certainly is, and if, at the same time, the muscular tissue is not increased, the additional substance must be elastic or ordinary

[1] We have seen something of the kind in peripheral vessels, but could not pronounce upon its character.

connective tissue. There is no other way of measuring it, for the breadth of the layers, which suggests itself for measurement, will tend to vary inversely with the dilatation of the vessel, and it would be impossible to establish a reliable standard for it.

Beside this increase we have seldom observed changes upon which any weight could be laid. In early life the blood supply to the media is conveyed in capillaries and arterioles which are not traceable beyond the outer third of the tunic. In later life they are sometimes found further in. This was noted in Nos. 25, 43, 50, 89. In these cases there seemed also to be many more small round connective-tissue nuclei along these little vessels than is natural. Twice, as above mentioned, in No. 90, and in another, we have seen large areas of fibro-cellular connective tissue, evidently of new formation, interrupting the ordinary layers of the media, partly separating and partly destroying them. These, however, were quite exceptional.

Endarteritis of the vasa vasorum was seen in two cases, Nos. 43 and 89, alone.

In eight cases, Nos. 25, 50, 67, 69, 83, 84, 85, 95, there were patches in the middle layers, which, by van Giesson's method, stained deeply with hæmatoxylin, and appeared granular, and by the alum carmine method looked mossy, though unstained, instead of clear and homogeneous, as connective tissue by this method should.

This is the sum of our observations. The changes described are quite insufficient to account for the general and progressive loss of elasticity that takes place, but we should be quite prepared to believe either that a simple increase in these tissues might tend to stiffen the vessel, or that the stiffening is due to a change we are unable to appreciate.

The conclusions which we draw are therefore as follows:

1. The aorta follows the law laid down by Wertheim for the elasticity of organic bodies.

2. Its width increases with age as the result of the internal pressure exercised upon it by the natural forces of the circulation.

3. The more it thus becomes dilated, the less is it capable of being further stretched.

4. When stretched by weights up to 200 grammes aortas, even when dilated, retain the power of returning to their original volume.

5. No simple mathematical relation obtains between dilatation and loss of elasticity.

6. Elasticity depends chiefly upon the tunica media, and the loss of it chiefly to changes in this.

7. These changes do not lie in the muscular tissue.

8. The muscular tissue, though varying in amount in individuals, probably, except in rare cases, remains the same in each individual throughout adult life.

9. The tunica media increases in substance with age.

10. This increase is to be ascribed to the elastic, or to the structureless connective tissue, or to both.

11. It is to the changes in these latter tissues that the loss of elasticity is to be ascribed.

12. The histological alterations, other than simple increase, are not sufficient to account for this loss.

TABLE OF CASES

TABLE I.—*Table of Cases.*

No. of case.	Name.	Age.	Aorta.		Stretch of aorta in cm.				Heart.		Cause of death and remarks.
			Width in cm.	Condition of intima.	Wt. 50 g.	Wt. 100 g.	Wt. 150 g.	Wt. 200 g.	Weight in oz.	Condition.	
1	A. S.	16	4·4	Nat.	9·5	16·0	20·6	—	10	Nat.	Intestinal obstruction; kidneys 15 oz., congested; chronic and acute nephritis.
2	R. M.	18	4·4	,,	8·3	14·2	17·9	—	8	,,	Exophthalmic goitre; kidneys 15 oz., congested.
3	C. M.	19	4·3	,,	8·3	13·8	17·2	—	20	Septic endocarditis	Infarcts in spleen and kidneys; kidneys otherwise nat.
4	C. C.	19	4·3	A few streaks	10·5	16·4	20·2	—	10	Nat.	Cerebral tumour; kidneys 12 oz., nat.
5	W. K.	22	4·4	,,	9·6	15·7	20·0	—	22	Mit., tricusp., and aortic incompetence; pericarditis	Heart disease; kidneys 14 oz., congested.
6	A. C.	23	4·3	Nat.	9·3	15·0	19·2	—	14	Septic endocarditis	Kidneys nat.
7	C. H.	23	4·7	A few streaks	8·1	13·3	16·8	19·4	10	Nat.	Phthisis; tubercular laryngitis; kidneys nat.
8	W. A. S.	24	5·4	Nat.	7·7	13·3	17·6	—	10½	,,	Poisoning by carbolic acid. All viscera nat. except stomach, etc.
9	W. P.	24	4·3	,,	7·7	13·1	16·3	18·3	8	,,	Sarcoma of liver and peritoneum.
10	R. M.	25	4·6	Consid. ath.	10·0	15·6	20·1	—	8½	,,	Cancer of sigmoid flexure and liver; kidneys 9 oz., nat.
11	J. W.	25	4·4	Nat.	6·2	11·0	14·4	18·2	11	,,	Perityphlitis; peritonitis.
12	T. S.	26	5·3	Streaks and patches	9·2	14·6	18·5	—	31	Aortic and mitral disease	Heart disease; kidneys 10 oz., congested.

13	R. B.	26	5·0	Nat.	8·5	13·9	17·6	—	—	Hypertrophied and invaded by growth	Sarcoma of mediastinum.
14	W. I.	26	4·5	A few streaks	8·6	15·0	19·8	—	14	Hyp. of l. v.	Chronic nephritis.
15	T. H.	26	4·9	„	8·7	13·6	17·0	19·0	12	Pericarditis	Sarcoma of intestine; kidneys nat.
16	J. F. A.	28	4·9	Nat.	9·2	15·1	19·1	—	9	Nat.	Suicide by cut throat. Kidneys nat.
17	E. R.	28	4·4	Slight ath.	8·4	13·5	16·9	19·2	—	Hyp. of r. v.	Sacculated bronchiectasis; kidneys 16 oz., congested.
18	J. E.	28	5·1	Very thick, consid. ath.	9·3	15·1	19·2	—	34	Aortic and mitral incompetence	Kidneys 18 oz., congested.
19	A. S.	29	4·5	Nat.	9·5	15·6	19·6	—	14½	Recent endocarditis and pericarditis	Heart disease.
20	E. L.	29	4·8	„	9·0	14·1	17·3	19·1	8	Nat.	Cancer of stomach.
21	H. S.	30	4·5	Some ath.	9·3	15·0	19·0	—	13	„	Cancer of axillary glands.
22	H. S.	30	4·5	A few streaks	8·1	13·5	17·0	19·0	11	„	Tuberculosis; meningitis.
23	W. E.	31	4·9	Nat.	10·0	15·7	18·9	—	11	„	Suicide. Kidneys nat.
24	W. B.	32	4·9	A few streaks	9·5	15·8	19·5	—	11	„	Pneumonia; other organs nat.
25	W. A.	33	5·1	Thick, very ath.	8·6	13·0	15·1	16·5	19	Valves nat.; much hyp. and dil.	Kidneys 14 oz.; diffuse nephritis; general arterial sclerosis; uræmia.
26	W. B.	34	5·0	Nat.	8·2	13·4	17·1	19·5	9½	Nat.	Thrombosis of cerebral sinus; costal abscess; kidneys nat.
27	W. B.	34	5·6	A few specks	7·7	12·6	15·9	17·9	8	„	Pyæmia.
28	W. D.	34	5·2	Nat.	8·0	13·8	17·6	19·8	14	Valves nat.; dil.	Cancer of stomach and peritonitis.
29	C. C.	35	4·8	„	9·3	15·5	19·4	—	13	Nat.	Pneumonia.
30	T. T.	35	4 5	A few streaks	9·4	15 0	18·7	—	11	„	Pneumonia.
31	H. C.	35	5·4	Nat.	8·6	13·4	16·1	17·5	16	Septic endocarditis	Kidneys 15 oz.; diffuse nephritis.

No. of case.	Name.	Age.	Aorta.		Stretch of aorta in cm.				Heart.		Cause of death and remarks.
			Width in cm.	Condition of intima.	Wt. 50 g.	Wt. 100 g.	Wt. 150 g.	Wt. 200 g.	Weight in oz.	Condition.	
32	H. P.	36	4·8	Nat.	9·8	15·0	18·0	19 7	14	Hyp. and dil. of r. v.	Bronchitis and emphysema; kidneys 15 oz., congested.
33	G. H.	36	5·1	Some streaks	8·0	14·1	17·5	19·7	9	Nat.	Diabetes mellitus.
34	W. B.	37	5·0	,,	9·3	14·6	18·0	—	10	,,	Tuberculosis.
35	E. S.	38	5·3	A few specks	6·8	11·2	13·6	14·9	10	,,	Gastric perforation; kidneys nat.
36	F. T.	38	5·4	Nat.	8·5	14·2	17·2	18·7	15	,,	Phthisis; kidneys 12 oz., nat.
37	G. W.	40	5·5	,,	7·9	12·0	14·4	16·0	9½	,,	Cancer of stomach; kidneys 8 oz., very granular.
38	F. B.	40	5·6	A few streaks	8·6	13·7	17·1	19·1	10	,,	Typhoid fever; hæmorrhage; kidneys 12 oz., nat.
39	S. G.	41	4·7	,,	9·5	14·4	17·4	19·1	8	,,	Typhoid fever; perforation.
40	T. P.	43	5·3	Very hard with gristly patches	7·4	10·6	12·1	13·0	9	,,	Cancer of rectum; kidneys nat.
41	J. D.	43	5·0	Nat.	10·0	15·2	17·9	19·4	14	,,	Pyæmia.
42	G. N.	43	5·2	,,	7·3	12·0	15·4	16·9	12	Hyp. of l.v., dil. of r. v.	Phthisis; cirrhosis of liver; kidneys nat.
43	T. H.	43	5·9	Extreme ath. calcareous patches	8·3	12·1	13·9	15·0	25	Chronic endoc.; valves atheromatous	Heart disease; kidneys 21 oz., not granular.
44	E. P.	43	5·3	Nat.	8·8	13·8	15·7	16·7	10	Nat.	Tuberculosis, acute and chronic; cirrhosis of liver; kidneys nat.
45	F. H.	44	5·9	Some ath.	8·6	13·6	16·6	18·4	22	Mitral and aortic disease	Cystic degeneration of kidneys (weight 62 oz.)

47	W. W.	44	5·8	Some ath.	7·9	12·1	15·0	16·2	23	Valves nat., much hyp.	Arterial sclerosis; cerebral hæmorrhage; kidneys 11 oz., nat.
48	A. F.	45	5·9	Consid. ath.	8·3	12·6	15·1	16·4	—	Nat.	Fracture of skull.
49	A. W.	45	5·6	Much ath.	7·2	11·5	13·6	14·6	12	„	Stricture of urethra; peritonitis.
50	J. A. S.	45	5·2	Nat.	8·3	12·9	15·0	15·8	10	„	Phthisis; general tuberculosis.
51	A. H.	45	6·1	Very thick; much ath.	5·2	6·1	6·7	7·1	23½	Aortic regurg.; hyp. of both v.	Granular kidneys; syphilis.
52	D. P.	46	5·2	Much ath.	7·5	11·7	13·9	15·1	15	Valves nat.; hyp. of l. v.	Cerebral hæmorrhages; broncho-pneumonia; hydatid of liver; gout; kidneys 9 oz., granular.
53	S. S.	46	5·1	Slight ath.	8·0	13·0	16·3	17·4	19	Fatty degeneration	Chronic diffuse nephritis; tumour of bladder; cirrhosis of liver; gout.
54	M. W.	46	5·6	Nat.	8·5	12·8	14·9	17·8	16	Valves nat.	Suicide by gunshot.
55	W. N.	47	5·6	A few streaks	7·1	12·6	16·7	18·0	10	Nat.	Perforation of duodenal ulcer.
56	R. J.	47	5·8	Hardly any ath.	8·1	12·2	14·6	15·9	18	Valves nat.	Pneumonia; kidneys 10 oz., granular.
57	H. R.	47	6·8	Thick; much ath.	6·6	9·5	10·7	11·5	14	Hyp. of l. v.	Run over. Arterial sclerosis; old phthisis.
58	F. W.	47	5·8	Very slight ath.	7·8	12·8	15·3	16·9	18	Some hyp. and dil.	Cerebral injury.
59	M. O'B.	48	6·0	Some ath.	7·2	10·4	11·8	12·6	16	Valves nat.	Pneumonia; cirrhosis of liver; kidneys 18 oz.; chr. interst. neph.
60	J. A.	49	5·1	Nat.	7·9	12·0	14·1	15·1	11	Nat.	Perforation of gastric ulcer; kidneys nat.
61	E. S.	50	6·4	Thick; much ath.	7·0	8·5	9·3	9·9	12½	Dil. of both v.	Angina pectoris; coronaries ath.

No. of case.	Name.	Age.	Aorta.		Stretch of aorta in cm.				Heart.		Cause of death and remarks.
			Width in cm.	Condition of intima.	Wt. 50 g.	Wt. 100 g.	Wt. 150 g.	Wt. 200 g.	Weight in oz.	Condition.	
62	J. J.	50	6·2	Some ath.	7·9	11·2	12·8	13·8	9	Slight ath. of valves	Cancer of pylorus; pneumonia; kidneys healthy.
63	O. S.	51	6·3	Extreme ath.	7·8	10·3	11·6	12·5	16	Hyp. and dil.	Rupture of aortic aneurysm; cirrhosis of liver; kidneys 12 oz., nat.
64	H. P.	52	5·6	Slight ath.	7·1	10·9	12·9	14·0	10	Nat.	Diabetes mellitus; pancreas atrophied; kidneys 12 oz., nat.
65	T. N.	52	6·0	Many streaks	8·2	12·3	14·2	15·2	11	,,	Cancer of thymus and liver.
66	A. N.	52	6·2	Much ath.	7·0	9·8	11·1	11·8	11	Some ath. of valves	Cancer of œsophagus; kidneys nat., except for secondary growth.
67	E. P.	52	5·8	Nat.	7·6	11·5	13·6	14·8	10	Nat.	Cancer of rectum.
68	A. N.	53	6·4	Many patch.	7·6	12·1	14·3	15·4	11	,,	Sarcoma of jaw; pneumonia; gout.
69	J. R.	54	6·5	Many streaks	6·9	8·9	9·8	10·3	7	,,	Cancer of stomach; kidneys 9 oz., granular.
70	J. C.	54	5·6	Consid. ath.	8·0	11·6	13·0	13·8	8½	,,	Pulmonary tuberculosis; kidneys 10 oz.; slight interstitial nephritis.
71	E. W.	54	6·3	,,	7·4	11·1	12·6	13·7	16	Valves nat.; hyp. of l. v.	Cerebral hæmorrhage; arterial sclerosis; kidneys 5 oz.; extreme interstitial nephritis.
72	B. R.	56	5·2	Nat.	8·5	12·8	15·0	16·3	10	Nat.	Empyema; gangrene of lung.
73	W. T. D.	56	6·0	Consid. ath.	5·9	8·5	9·6	10·3	12	Valves nat.; fatty degen.	Sarcoma of skull; kidneys 15 oz., nat.
74	J. G.	56	6·2	Some ath.	7·6	11·2	13·2	14·5	—	,,	Sarcoma of mediastinum and heart; kidneys 11 oz., granular; syphilis.
75	H. D.	56	5·6	Arteries	5·9	8·0	9·1	9·8	11	,,	Fractured leg; pyæmia; alcoholism.

76	P. W.	58	6·1	Nat.	7·2	12·0	14·7	16·2	16	Dil. of r. v.	Tuberculosis.
77	E. E.	58	5·7	„	7·3	10·2	11·8	13·1	10	Nat.	Cirrhosis of liver; cholæmia; kidneys 9½ oz., nat.
78	P. S.	59	6·0	Consid. ath.	7·3	11·1	13·2	14·4	10	„	Gastric ulcer; hæmorrhage; kidneys 10 oz., granular.
79	J. C.	59	6·0	Slight ath.	7·0	9·6	11·2	12·0	8½	„	Cancer of stomach.
80	G. B.	59	5·7	Some ath.	7·1	11·3	13·5	14·8	15	Dil. and hyp.; fatty degeneration	Lymphatic leukæmia; kidneys 18 oz., nat.
81	G. F.	60	6·3	Thick; some ath.	7·9	11·6	13·6	14·9	15	Valves nat.; hyp. of l. v.	Hæmatemesis; cirrhosis; chronic nephritis; gout; kidneys 9 oz., very granular.
82	J. M.	60	5·5	A few specks	8·3	12·6	15·0	16·3	15½	Valves nat.	Suicide by hydrochloric acid. Kidneys 8 oz., granular.
83	W. B.	60	6·3	Some ath.	6·8	10·1	11·5	12·2	23	„	Cerebral hæmorrhage; arterial sclerosis.
84	J. H.	60	6·5	Thick; a few specks	7·7	10·7	12·3	13·5	16	Dil.	Pernicious anæmia.
85	H. B.	61	6·4	Much ath.	6·4	9·6	11·1	11·9	20	Valves nat.; much hyp. of l. v.	Convulsions; granular kidneys. No other cause of death.
86	T. F.	61	6·4	Some ath.	7·3	11·2	13·4	13·7	10	Nat.	Cancer of pancreas; kidneys 19 oz., not granular.
87	T. D.	62	6·2	Very thick; some ath.	6·1	8·7	10·0	10·7	16	Hyp. of l. v.	Kidneys 12 oz.; chronic interstitial nephritis; uræmia.
88	W. C.	63	5·8	Very thick; much ath.	3·4	4·1	4·5	4·9	8	Nat.	Cancer of stomach.
89	J. W.	63	7·0	Very thick; extreme ath.	4·1	5·2	6·1	6·6	13½	Ath. of valves	Cancer of tongue.
90	G. B.	63	6·2	Much ath.	5·9	8·0	9·1	9·9	15	Valves nat.; hyp. of l. v.	Chronic nephritis; kidneys 24 oz., granular; pericarditis.

No. of case.	Name.	Age.	Aorta.		Stretch of aorta in cm.				Heart.		Cause of death and remarks.
			Width in cm.	Condition of intima.	Wt. 50 g.	Wt. 100 g.	Wt. 150 g.	Wt. 200 g.	Weight in oz.	Condition.	
91	H. C.	64	6·2	Consid. ath.	7·0	10·0	11·6	12·5	15	Nat.	Death by burning.
92	J. B.	65	5·3	Thick; some ath.	6·5	8·5	9·4	10·0	8	„	Cancer of larynx; pneumonia.
93	J. B.	65	6·3	Some ath.	6·8	10·3	11·9	12·8	16	Aortic regurgitation	Pneumonia; kidneys nat. except small tubercular deposit.
94	J. C.	65	6·4	Much ath.	6·5	8·5	9·5	10·1	10	Nat.	Cancer of pancreas; kidneys granular.
95	J. S.	67	6·3	Some ath.	3·2	4·0	4·5	4·9	9	Mitral stenosis and ath.	Cancer of œsophagus.
96	J. T.	68	6·6	Much calcification	3·4	4·5	5·1	5·7	13	Hyp. of l. v.	Pneumonia; pleurisy; pericarditis; kidneys granular; gout.
97	E. C.	69	6·7	Some ath.	7·0	8·9	9·8	10·6	14	Nat.	Sarcoma of jaw.
98	J. M.	70	6·9	„	5·6	6·8	7·5	8·0	16	Hyp. of l. v.	Cerebral hæmorrhage; arterial sclerosis; granular kidneys.
99	A. S.	74	6·5	Thick; much ath.	5·5	7·5	8·4	8·9	16	„	Urethral stricture; chronic nephritis.
100	J. S.	78	6·8	Some ath.	2·3	3·1	3·7	4·1	9½	Nat.	Cancer of pleura.

TABLE II.

Averages.

Age.	A. Width of aorta in cm.				B. Stretch of aorta in cm.				
	All cases.	Intima natural	Slight atheroma.	Much atheroma.	Load in grammes.	All cases.	Intima natural.	Slight atheroma.	Much atheroma.
Under 30	4·64	4·61	4·53	5·0[1]	50	8·78	8·4	8·98	9·5[1]
					100	14·40	14·1	14·58	14·43
					150	17·89	18·27	18·45	19·26
					200[2]	—	—	—	—
30—39	5·0	5·07	4·63	5·1[3]	50	8·82	8·91	8·51	8·6[3]
					100	14·11	14·43	13·98	13·0
					150	17·41	17·76	17·4	15·1
					200	>18·32[4]	>19·04[4]	>17·88[4]	16·5
40—49	5·65	5·27	5·53	5·76	50	7·91	8·39	8·05	7·21
					100	12·18	12·96	12·74	10·58
					150	14·61	15·34	15·72	12·29
					200	16·06	16·81	17·22	13·24
50—59	5·99	5·68	5·94	6·17	50	7·32	7·3	7·34	7·31
					100	10·64	10·9	10·84	10·42
					150	12·33	12·84	12·72	11·87
					200	13·33	14·04	13·82	12·73
Over 60	6·33	—	6·28	6·29	50	5·88	—	6·29	5·28
					100	8·20	—	8·86	7·18
					150	9·4	—	10·21	8·18
					200	10·11	—	10·98	8·81

[1] This class contains only 3 cases.

[2] At this weight most of these stretched beyond the limits of the recording paper.

[3] This class contains only 1 case.

[4] As some of these stretched beyond the paper the average taken is less than the actual.

Table III.

No. of case in Table I.	Age.	Thickness of intima in mm.	Thickness of media in mm.	No. of nuclei in strip 1 mm. wide.	Width of aorta in cm.	Total No. of nuclei in aorta.
1	16	0·020	0·784	257·25	4·4	1,131,900
2	18	0·045	0·897	356·125	4·4	1,566,950
7	23	—	—	236·875	4·7	1,113,312
8	24	0·029	0·853	247·50	5·4	1,336,500
13	26	0·035	0·890	255·375	5·0	1,279,350
14	26	0·155	1·020	259·25	4·5	1,166,625
16	28	0·055	0·833	176·812	4·9	866,378
17	28	0·063	0·770	257·5	4·4	1,133,000
19	29	0·100	1·124	258·25	4·5	1,161,625
20	29	0·010	1·068	218·375	4·8	1,048,200
		Average	0·915	252·331		1,180,384
22	30	0·040	0·986	204·75	4·5	921,375
24	32	—	—	205·25	4·9	1,005,725
25	33	0·560	0·766	205·375	5·1	1,047,412
26	34	0·014	0·900	242·875	5·0	1,214,350
28	34	0·175	0·984	206·125	5·2	1,071,824
32	36	0·072	0·800	207·562	4·8	996,297
33	—	0·057	1·015	314·875	5·1	1,605,862
35	38	0·140	1·156	235·25	5·3	1,246,825
		Average	0·944	227·757		1,138,709
39	41	0·089	0·938	368·25	4·7	1,730,775
41	43	0·035	0·693	174·25	5·0	871,250
43	43	0·048	0·933	129·75	5·9	765,525
45	44	0·110	0·989	173·375	5·9	1,052,412
49	45	0·188	0·720	178·50	5·6	999,600
50	45	0·178	1·044	258·75	5·2	1,345,500
52	46	0·230	1·064	200·625	5·2	1,043,250
53	46	0·200	0·742	166·375	5·1	848,512
55	47	0·010	1·060	325·875	5·6	1,924,900
57	47	0·559	0·716	202·375	6·3	1,274,931
58	47	0·334	0·750	101·819	5·8	590,550
60	49	0·284	0·980	192·25	5·1	980,475
		Average	0·885	206·4		1,152,306

TABLE III (*continued*).

No. of case in Table I.	Age.	Thickness of intima in mm.	Thickness of media in mm.	No. of nuclei in strip 1 mm. wide.	Width of aorta in cm.	Total No. of nuclei in aorta.
62	50	0·208	1·302	203·125	6·2	1,218,750
67	52	0·134	1·122	189·75	5·8	1,100,550
68	53	0·141	0·943	191·25	6·4	1,224,000
69	54	0·134	1·030	79·625	6·5	517,562
71	54	0·104	1·312	209·75	6·3	1,421,425
77	58	0·212	0·838	134·75	5·7	796,575
79	59	0·158	1·148	166·00	6·0	996,000
		Average	1·099	167·75		1,039,266
81	60	0·136	1·146	171·25	6·3	1,078,875
82	60	0·165	1·102	211·75	5·5	1,164,625
83	60	0·235	1·044	108·75	6·3	695,125
84	60	0·210	1·254	178·875	6·5	1,162,655
85	61	0·230	0·960	235·425	6·4	1,506,720
89	63	—	—	233·875	7·0	1,637,125
95	67	0·133	1·033	125·00	6·3	787,500
99	74	0·179	0·924	202·75	6·5	1,317,875
		Average	1·066	183·45		1,168,812

DISCUSSION.

Professor T. CLIFFORD ALLBUTT congratulated Dr. Herringham and Dr. Wills on their application to medicine of a graphic method, which was calculated to give precise results. Clinical medicine rested in obscurity because of the difficulty of bringing methods of precision to bear upon its problems. Personally he was much interested in the research, as he had been informally associated with the late Professor Roy in a similar investigation, and he had for long taken great interest in the cardio-vascular changes occurring at different periods of life. Roy's results were, however, supposed to have been invalidated by Professor T. A. McWilliam's demonstration of the post-mortem contraction, which continued even for a week after death in the aorta as well as in more muscular vessels. He would be glad to know how this contraction was dealt with by Dr. Herringham and Dr. Wills. He was interested to note that so far his own opinions were corroborated in a large class of arterial disease the latter was not primary, but consequential to high blood-pressures. The aorta did not shorten as it dilated in response to the ventricular systole; in other words, closed arteries did not obey the laws of the excised vessel-wall. A relaxed artery lengthened more than a contracted artery, and it might be anticipated that if there were universal arterial contraction much tortuosity would not occur. He hoped that the elongation of arteries under high blood-pressures would be estimated, and that the question would be answered as to whether such elongation would result appreciably if vaso-motor contraction persisted for long periods. Dr. Gutch had demonstrated that muscular compensation in the heart and arteries was not by numerical increase of fibres, and to test this in the aorta was, in his opinion, an ingenious device. He trusted that the chemical investigations would be carried on as promised. Two of his own graduates were engaged at present in incinerating lengths of artery from various parts and at various ages to ascertain whether, in arteries not obviously diseased, the mineral constituents underwent any definite and regular increase as life advanced.

Dr. A. G. AULD said that some years ago, in conjunction with the late Professor Coats, he had made histological researches on the aorta, which confirmed in every particular but one the results of the paper. They had obtained clear evidence that the elastic tissue underwent in some cases a granular degeneration, which was limited to the very fine fibres between the laminæ. This seemed to have a bearing on the loss of elasticity described in the paper.

Even though such changes might not be seen in all cases, yet they would suggest the occurrence of functional changes in all. Besides, elastic tissue was the chief constituent of the media, and it would be remarkable if the presence of so much elastic tissue in the aorta had not the main influence on its extensibility. The increase of connective tissue would also produce stiffening of the vessel-wall, and thus interfere with the action of the elastic fibres.

Dr. ALEXANDER MORISON considered it desirable that the terms used in discussing sclerosis in the aorta should be brought so far as possible into line with those suitable in discussing the same process in the smaller arteries. In the latter he considered that the structure chiefly affected was the intima, or submuscular layer of fibrous and connective tissue, which, in these vessels, was clearly marked off from the muscular coat (known here as the *media*) by the membrane of Henle. In the case of the aorta this separation was not so defined, and the muscular coat of the vessels was much interspersed with the fibrous and connective tissue, which in the arteries was distinctly submuscular. He considered that the latter term would be less misleading than the use of the term "media," which he regarded as the equivalent of the intima in the arteries. Whether there were any hypertrophy of the muscular structures in the aorta in sclerosis of that vessel or no, he believed that there was a muscular hypertrophy in certain stages of sclerosis in the smaller vessels, and suggested that this view was borne out by the atrophy of that layer found in the case of calcareous arteries, which had to be decalcified before section, and in which, from their absolute rigidity, the muscular coat had for long been inactive. He saw no reason why vascular muscle should not increase in size under circumstances of impediment, as it was constantly observed in the case of other visceral muscles; but, although he had observed a granular degeneration of arterial fibrous tissue under high powers of the microscope, he considered the chief cause of the loss of elasticity in arterio-sclerosis to be the increase in bulk of the fibrous and connective tissue elements.

Professor D. W. FINLAY said he hoped that similar observations might be made by the authors of the paper on the arteries of syphilitic and alcoholic patients, in view of the importance of the subject in connection with the ætiology of aortic aneurysms.

Dr. SEYMOUR TAYLOR said he would like similar observations made on arteries naturally tortuous,—the subjects of a tortuosity, which he believed probably depended on supplying parts of the body concerned with movement, and was not concerned with the resistance of systolic shock. It might be instructive, for example, to compare the elasticity of the naturally tortuous splenic artery with that of the straight radial artery.

The PRESIDENT alluded to the observation that cardiac hypertrophy had no connection with loss of elasticity of the aorta; this seemed to be borne out clinically. It was an interesting fact that the widening of the aorta reached its acme about the age of forty, for it was known clinically that the varied pressures due to conditions of stress began to tell about this period of life.

Dr. HERRINGHAM, in reply, agreed that observations on the elasticity of arteries in syphilis and alcoholism would be valuable, and also that others might well be made on naturally tortuous arteries. He could not recognise any submuscular layer in the aorta; the media was the muscular coat, the muscle being mixed with elastic tissue. In the cases they had examined, the elastic tissue was not altered in the manner described in aneurysm. As to any error from post-mortem contraction, Professor McWilliam had shown that concavity of curves was a sufficient criterion of a relaxed vessel, and the curves they had obtained were purely concave.

THE EFFECTS OF A PROTEID DIETARY (RAW MEAT)

AN EXPERIMENTAL AND CLINICAL STUDY.

BY

CHALMERS WATSON, M.B., F.R.C.P.E.

(COMMUNICATED BY DR. NEWTON PITT)

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MY object in this paper is to record the clinical and pathological appearances observed in an experimental research on prolonged feeding of fowls on a diet of raw meat, and to discuss shortly their bearings on disease in the human subject. The main facts to which attention will be directed are:

1. *Negative.*—The absence of any indications of gout (uratic deposits).
2. *Positive.*
   - (*a*) The variety in the clinical and pathological features observed in the different subjects.
   - (*b*) The lesions in the thyroid and parathyroid glands and bone marrow.[1]
   - (*c*) The very favourable manner in which one fowl affected with well-marked tuberculosis, was influenced by the diet.

[1] The consideration of the causation of the changes in the thyroid, parathyroid glands, and bone marrow is deferred to a later paper.

The application of these facts to disease in the human subject will be shortly discussed under the following headings:

***Firstly.*—The *rôle* of a proteid dietary—a diet rich in nucleins—in the induction of gout, and**

***Secondly.*—The dietetic treatment of tuberculosis, with special reference to the use of *raw* meat as a curative agent.**

This research was begun with the object of confirming or otherwise the recent interesting research of Kionka (1) on avian gout. It may at once be stated that the results obtained did not confirm those described in Kionka's record; the experiment was unsuccessful so far as the induction of gout was concerned. This negative result is of itself of much interest; the interest is enhanced by the changes incidentally observed in the thyroid glandular system, the bone marrow and other tissues in the non-tuberculous fowls, and by the distinctive character of the reactions in the tuberculous subject.

Details of the experiment.—The observations were begun on March 10th, 1900, and consisted in feeding eight fowls, six hens and two cocks, on a diet of raw lean meat and water. Four of the fowls were a year old, and four were just under two years of age. The subjects were of a common farmyard stock. For the first six months seven of the fowls were kept in the country, the animals being confined in a hen run by the side of a wall, the floor being composed of natural soil. This enabled the animals to have a fair amount of exercise, and also to supplement their diet by grit and other material from the soil. The remaining fowl, a cock, No. 6, was kept in an iron cage in the Physiological Department of the University during the whole course of the observations.

The fowls were fed on raw lean ox meat and a liberal supply of water. About the third month an attempt was made to substitute horseflesh (which had been cooked for purpose of preservation), but this was abandoned, partly on account of the difficulties in obtaining the meat, and

partly because this form of diet was not readily taken by the animals. Some sand and small grit was supplied from time to time. The observations continued until July, 1901, a period of sixteen months.

Clinical history.—For the first few months the fowls took the diet greedily, the average amount of meat taken by each fowl being rather more than three quarters of a pound per diem. In the later stages the appetites were not so keen, and at intervals the animals ate much less heartily, this defect in the appetite being usually associated with other symptoms. The hens appeared to thrive all right for the first few weeks, but about the sixth week slight indications of ill health set in. This was manifest in a very slight and just perceptible lameness, which later became more pronounced in one of the younger hens (No. 3) and one of the older birds. This tendency to lameness remained more or less throughout the whole course of the observation, but in the case of No. 4 it was not manifest after the fifth month. On several occasions when the lameness was distinct there was a manifest increased heat in the affected limb. A little later the fowls showed a greater tendency to sit, and would rest on the ground for much longer periods than was natural. They roosted each night.

Eggs.—At the outset of the observations the number of eggs markedly increased, this increase persisting for about four weeks, when a gradual diminution set in, terminating in complete cessation. The yolks of the eggs became particularly pale; a baked custard and a dish of scrambled eggs made with them were perfectly void of colour, and appeared more like thick curds. After four months of the diet the eggs were not edible, on account of decomposition-changes which were revealed in the process of cooking.

Skin.—In about six weeks from the outset the feathers of some of the birds became disarranged. The tails drooped, and the birds appeared out of sorts generally. Several of the fowls lost many of their feathers; one fowl

was almost denuded of its feather covering, the loss being hastened by its companions picking off the feathers. About this time the fowls showed a marked tendency to pick the lime off the walls, and continued doing so for some time. The cutaneous disturbance is shown in the illustration (Fig. 1).

FIG. 1.

Illustrates a paralytic attack which developed after six months' raw-meat diet, and also at later intervals, see p. 536. Note also the cutaneous disturbance.

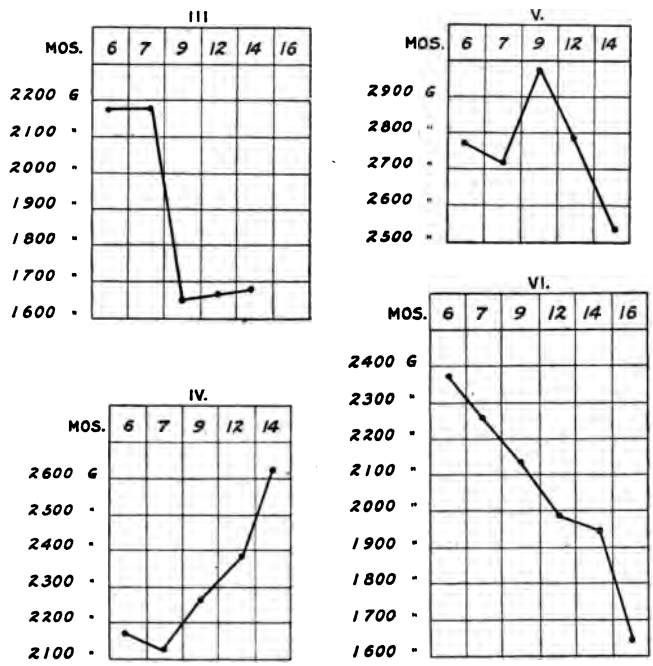
Combs.—The combs of all the fowls became pale in colour, indicating anæmia. The degree of pallor varied, and was not constant. In some cases it was associated with great duskiness of the comb in its most dependent parts. An examination of blood films taken just before death from two fowls, Nos. 3 and 6, showed very striking deficiency of white blood corpuscles.

The later history of the eight fowls may be summarised:

(*a*) At the end of six months two of them were returned to the yard in apparent perfect health.

(*b*) Two had succumbed to acute nervous derangements at the fourth and seventh months respectively. The animals went off their food, showed symptoms of paralysis and defective co-ordination, rapidly became unconscious, and died. No gross lesions were observed at

FIG. 2.



Record of weights of four fowls fed on raw meat for 14 to 16 months. Nos. III, V, and VI showed great hypertrophy of thyroid and parathyroid glands. In No. IV these glands appeared normal; this fowl was affected with intestinal and hepatic tuberculosis.

the post mortem; there was no trace of uratic deposits. The macroscopic and microscopic records are not so complete as in the later group.

(*c*) Of the four remaining fowls, which were subsequently observed in the laboratory of the Physiological

Department of the University, the chart (Fig. 2) illustrates the records of weights. Attention is specially directed to the following points.

1. No 4 steadily gained in weight in place of losing, as in the other cases. This subject had, throughout the course of the observation, shown a much greater tolerance of the diet than its fellows. At the post-mortem examination this fowl was found to be tuberculous.

2. While the other animals lost weight, the loss in the case of No. 6 was remarkably steady and continuous (see chart). This animal was unique in showing profound atrophic changes in the intestinal tract. This animal was fed in the laboratory throughout the whole course of the experiment.

The terminal histories are of interest. No. 3, which all along had been the most injuriously affected by the diet, was killed on the fourteenth month on account of the supervention of a third attack of paralysis. These attacks were characterised by marked paralysis and loss of appetite, lasting about a week; they were spontaneously recovered from without any change in the *régime*. Fig. 1 illustrates the paralysis, and also the cutaneous disturbance present during one of these attacks. It will be observed that the paralysis involved mainly the extensors of the limb.

No. 4 remained remarkably well until the end of the thirteenth month, when it appeared ailing. It rested much and ate less. At the end of the fourteenth month it developed symptoms very similar to those of strychnine poisoning (opisthotonos, spasms, etc.), but with this distinction, that the symptoms did not appear to be aggravated by handling the animal. The terminal symptoms in this case were unlike those seen in any of the others.

No. 5 (cock).—At the thirteenth month symptoms of distinct paralysis (acute) were manifested, the weakness being much more pronounced on one side. The animal could not maintain itself in the sitting posture, but fell invariably to one side. The general nutrition of the

animal had been fairly well maintained, and the loss of weight was not considerable.

No. 6 (cock, black).—The general nutrition of this animal was poor. Many of its feathers had gradually assumed a brown tint; the comb showed a combination of pallor and duskiness. The fowl became paretic, and it was observed that in walking the right leg was raised higher and put down more sharply than its fellows. Blood films taken before death showed very pronounced leucopœnia.

Before passing from the consideration of the clinical picture, reference may be made to the striking absence of the clinical features of gout. The occasional lameness and increased heat in the affected limbs were the only symptoms which in any way resembled those of gout. Both the subsequent history and the entirely negative post-mortem evidences show that the attempt to induce gout was entirely unsuccessful. If any doubt exists on this point that will be dispelled by a reference to the illustrations of Kionka, which show the presence of marked uratic deposits in the limbs of animals in which these local symptoms had been much more severe than in the author's observations. It is worthy of note that Kionka only succeeded in inducing gout in a small proportion of his cases.

Pathological Appearances.

An examination of the two fowls that succumbed at the fourth and seventh months respectively revealed no gross lesions. There was no trace of uratic deposits in the articulations or other tissues. The serous membranes, liver, spleen, kidneys, and heart showed no abnormality. *Histologically* the livers showed a moderate degree of cellular infiltration along the portal tracts and bile ducts, with considerable deposit of pigment throughout the organ. The renal epithelium contained many fine pigment granules. The spleens were not enlarged; they showed some

pigment deposit. There was no trace of vascular disease in any of these organs, and their parenchyma generally presented a normal appearance. As the examination of these cases was, however, especially directed to the presence or absence of manifestations of gout, the actual records are less complete than in the larger number of cases which survived for longer periods.

No. 4 fowl, after fourteen months on raw meat diet. The general nutrition was good (see chart). All the organs and tissues appeared healthy, with the following exceptions:

(*a*) The liver was studded with small caseous-looking nodules, which varied in size from the head of a pin to a small bean. Microscopic examination (and the application of suitable staining methods, carried out for me by Mr. Richard Muir, of the Pathological Department of the University) revealed their tuberculous nature.

(*b*) The lowest part of the ileum, for a distance of six inches, showed numerous small circular ulcers. On histological examination characteristic tuberculous nodules were seen in the mucous, submucous and muscular coats; the ulcers were produced by the extrusion of small caseous masses.

(*c*) The bone-marrow was unduly dark in colour, and microscopically was of a leucoblastic type. The microscopic examination of the spleen, kidneys, heart, thyroid, pancreas, and muscular system revealed no abnormal appearances.

Similarly, the examination of the spinal cord at three different levels failed to reveal any indication of (*a*) disease of the vessels, or (*b*) degeneration of nerve-fibres (Marchi and Weigert-Pal methods). The systemic vessels generally appeared perfectly healthy, with the exception of one artery (sciatic) which showed a well-marked patch of endarteritis. This may have been due to a previous thrombosis.

Fowls 3, 5, and 6.—After fourteen and sixteen months' raw meat diet. No trace of gout was present. These

fowls, unlike the former, showed some pronounced lesions. Of these the only changes common to all of them were found in the thyroid and parathyroid glands. The thyroid gland was much enlarged in the case of Nos. 3 and 6 (see Fig. 3), and enormously so in No. 5. The weights of the two glands in the last mentioned were 9·5 grammes and 3·0 grammes respectively. Histological examination showed:

i. Increase in size of the vesicles, which were filled with colloid substance which stained perfectly.

FIG. 3.

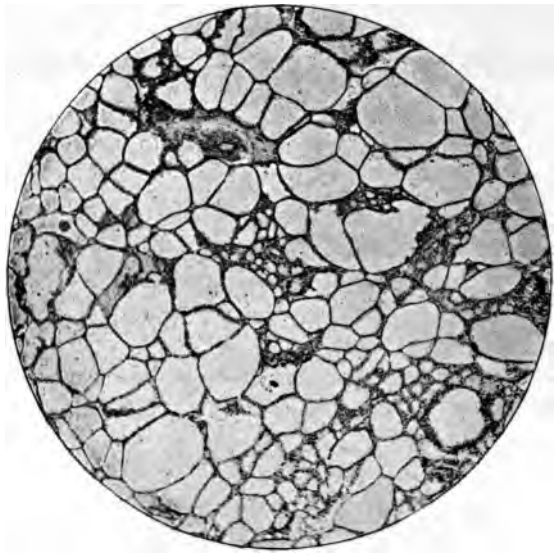
Great hypertrophy of thyroid and parathyroid glands after prolonged feeding on raw meat. Weight of one parathyroid gland (Nos. III and VI) was ·095 and ·10 grm. Weight of one thyroid gland (Nos. III and VI) was 1·25 and 1·15 grm. The average weight of a normal thyroid is ·14 grm.

ii. Diminution in the intervesicular glandular tissue (see Fig. 5).

iii. Increase in the number of cells in the wall of vesicles (see Fig. 5).

The enlarged glands in No. 5 showed well-marked hæmorrhages into the vesicles. The *parathyroid* glands were very markedly enlarged in all three cases, more especially in Nos. 3 and 6 (see Fig. 3). Normally these glands are not visible to the unaided eye; in these three animals the glands stood out as more or less globular masses distinctly larger than a pea (see Fig. 3). Histo-

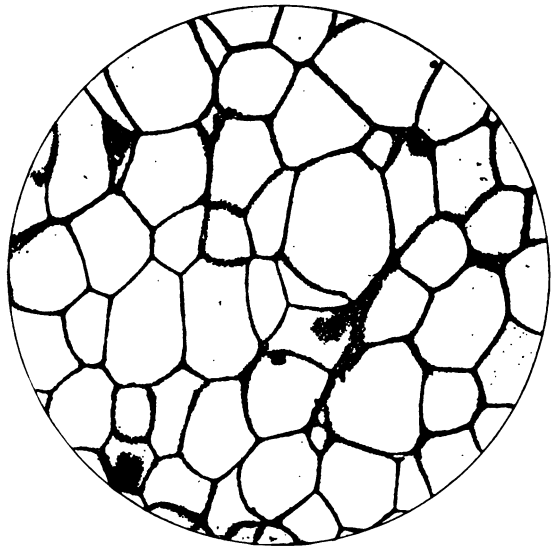
FIG. 4.



Thyroid gland from normal fowl. × 50. Cf. Fig. 5.

Observe—i. The size of the vesicles.
ii. The thickness of walls of the vesicles.
iii. The large amount of intervesicular glandular tissue.

FIG. 5.



Thyroid gland after 14 months' raw-meat diet. × 50.

Observe—i. The increase in size of the vesicles.
ii. The increased thickness of wall of vesicles.
iii. The disappearance of the intervesicular glandular tissue.

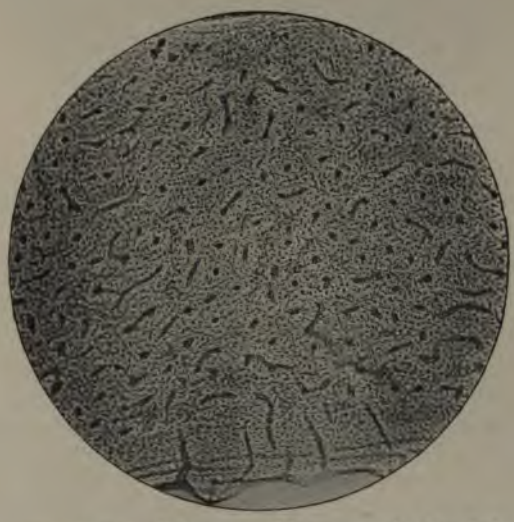
FIG. 6.

Transverse section of normal femur at the same level—

To show the changes in the osseous system after 14 months' raw meat—five sections.

Observe—i. The increase in thickness of the bone.
ii. The diminution and obliteration of the marrow cavity, due to the formation of an osteoid tissue, see p. 542.

FIG. 7.



Transverse section of the normal bone seen in Fig. 6, for comparison with Fig. 8.

logically the sections presented the appearance of normal parathyroid tissue.

Bone-marrow.—Very striking changes were found in the bony system in two cases (Nos. 3 and 6). In No. 3 the long bones were increased in thickness and irregular on their surface; the femora were markedly curved. On section of the long bones it was found that the marrow

FIG. 8.

Transverse section of the abnormal bone in Fig. 6. Same magnification as in Fig. 7. Unstained.[1]

had almost entirely disappeared (see Fig. 6), being replaced by fairly dense tissue. On microscopic examination the appearance was remarkable (see Fig. 8). The marrow

[1] From stained sections kindly made by Dr. Carnegie Dickson, of the Pathological Department of the University, it is seen that the large dark areas in the section represent concentric laminæ of imperfectly developed bone, the older laminæ staining faintly, the younger ones deeply. The Haversian spaces are reduced in size, and as the spaces become narrowed the vessels are obliterated. The spaces are void of osteoblasts and osteoclasts, and contain simply fat and an artery and vein.

proper was replaced by a non-cellular tissue presenting some of the characters of an osteoid tissue; a similar appearance was seen in the outer part of the bone (see Fig. 8). The large masses apparently represent much altered Haversian spaces, the appearances being due to an infiltration of some substance which stains pink with picrocarmine. Chemical examination showed a great increase in the proportion of organic matter. The appearances in the bone in No. 6 were of a similar character, but less pronounced. The marrow in No. 5 appeared unusually soft in consistence and dark in colour. It was not submitted to microscopic examination.

Other organs and tissues.—No uniform lesions were present; the organs were for the most part normal. The following lesions were, however, noted:

1. The intestinal tract in No. 5 showed very pronounced atrophic changes.
2. The duodenum in Nos. 5 and 3 was dilated.
3. The liver in No. 6 showed great amount of pigment.
4. The heart in No. 3 appeared to be hypertrophied.

The systemic vessels throughout showed no indications of disease of any of their coats; the vessels in the muscular system showed no abnormal appearance; and the same has to be said of the vessels in the spinal cord. There was no trace of degeneration of the nerve-fibres in the cord; in one section in No. 6 some minute capillary hæmorrhages (recent) were present in the grey matter.

The foregoing points may consequently be summarised as follows:—A profound hypertrophy of the thyroid and parathyroid gland in all three cases, associated with very marked changes in the bone-marrow in two instances. The negative features of interest are (*a*) the entire absence of uratic deposits; (*b*) the absence of renal disease, and (*c*) the healthy state of the blood-vessels throughout the system. These last two negative features have significance in relation to the commonly accepted view that a nitrogenous dietary leads to general vascular and renal disease.

The rôle of a Proteid Dietary—a Diet rich in nucleins—in the induction of Gout.

The facts here recorded have an important bearing on some generally accepted views of the appropriate dietary in gout. Of late years there has been a tendency, and probably a correct one, to abandon the long held "uric acid theory" of the disease. Coincidently with this change, however, the attention of investigators and clinicians has been increasingly directed to the "nucleins" of the food as the all-important ætiological factors, and in many recent writings the articles of diet allowed or forbidden have special reference to their richness or otherwise in nucleins or purin bases. This theory of origin of the disease will, I believe, soon share the fate of its predecessor. It is not my intention to discuss this point further than to indicate that in the results here recorded we have facts which strongly support this belief. It is well known that the physiological processes in the fowl render those animals specially prone to uratic deposits. Yet we have here a series of four animals fed on a pure raw-meat dietary for a very long period—fourteen to sixteen months,—and yet no trace of uratic deposits occurred. This appears to clearly indicate that a proteid dietary *per se* has no primary ætiological significance in gout. We previously stated that Kionka only succeeded in inducing gout in a small proportion of the subjects in his experiment. A variety of circumstances may have conspired to give him this positive result. Of these, in all probability the most important is the fact that in the cases in which he succeeded the animals were apparently highly-bred subjects, which are more susceptible to disease generally. Recently Kochmann (2), a pupil of Kionka's, has investigated the effects of a pure meat dietary in dogs. Here also the attempt to induce gout by this means was entirely unsuccessful. We are, therefore, justified in stating that a proteid dietary *per se* is not the main ætiological factor in the disease.

The writer has recently (3) recorded some facts from comparative pathology which support the view that there is an infective element in gout, the source of infection being the alimentary tract.

The Dietetic Treatment of Tuberculosis, with special Reference to the Use of Raw Meat as a Curative Agent.

The value of meat as an important constituent of the diet of tuberculous subjects has long been recognised, but it is only in recent years that special importance has been attached, especially on the Continent, to the value of *raw meat* as a curative agent. This interest has arisen mainly from the experimental researches of Héricourt and Richet on dogs which have been rendered tuberculous by intravenous injection of tubercle bacilli. These observers, as the outcome of a large amount of experimental work, demonstrated the following points:

1. That feeding tuberculous animals on raw meat gave remarkable results.

2. That cooked meat did not give the same effect as raw meat.

3. That the muscle plasma contained the active principles of the meat.

Their researches led them to conclude that raw meat, as opposed to cooked meat, had a specific effect in antagonising the tubercle toxin. In the discussion which followed Richet's paper the objection was raised that, as the animals had been artificially rendered tuberculous, the conditions *re* treatment were hardly comparable to tuberculosis in the human subject. It was further argued that the results obtained might be peculiar to the more strictly carnivorous animals. The present record meets these objections; the facts show that in this case of naturally acquired tuberculosis the results of feeding with a raw meat dietary confirm those recorded by the French observers for the artificially induced disease. It also shows that this favourable result is obtained in graminivorous animals.

In more recent experimental investigations Fränkel and Sobernheim (5) and also Lawrason Brown (6) have been unable to confirm Richet's results. While the records of these observers are of great interest, their results do not minimise the value of Richet's observations.

Very satisfactory results of the treatment of the disease in the human subject by raw meat after the manner of Richet and Héricourt have been recorded by Cornil and Chantemesse, Josias and Roux, Forbes Ross, and Angiulli in the 'Transactions of the British Congress of Tuberculosis,' 1901; but, although these and other clinical observers have recorded noteworthy results from this treatment, its value does not seem to be generally appreciated, and there is little reference to it in our own literature. Little is known as to the mechanism of this therapeutic action. The suggestion that the results are merely the outcome of superalimentation cannot be entertained. Héricourt and Richet considered that certain albuminoid ferments, which were largely destroyed in the process of cooking, were the active agents in raw meat therapeutics.

The subject has recently been further investigated by Galbraith (7). This observer studied the blood-changes in tuberculous subjects fed on a diet very largely composed of under-cooked or raw meat, and he records two features of special interest. Firstly, the presence of a very *pronounced digestive lymphocytosis*, to a degree considerably in excess of that obtained by other dietaries in patients similarly situated, and, secondly, *a very great and rapid increase in hæmoglobin percentage*. He lays great stress on the value of the lymphocytosis, which he regards as induced by the nuclein elements of the food. It is obvious that we have yet much to learn regarding the mechanism by which the raw meat diet overcomes the disease. In this connection some very suggestive facts are presented in the foregoing record. The remarkable changes in the thyroid and parathyroid gland in the three fowls can scarcely be regarded as an accidental circum-

stance void of significance—*re* the dietetic *régime* in vogue. The hypertrophy of these glands is interpreted as the outcome of the raw meat dietary. Importance is also attached to the coincident changes in the bone-marrow. It is probably advisable to defer theorising as to the exact nature of these relationships until a repetition of the experiments has confirmed the results. It may, however, be stated that the facts here recorded, considered alongside of the known facts of recent experimental observations (8) on the thyroid and parathyroid glands suggest that these organs play a much more important *rôle* in the internal defences of the organism than is commonly supposed.

We may further add that the results recorded in the present paper suggest that the favourable effects of treatment of many diseases by a milk *régime*—*e. g.* eclampsia, chorea, etc.—may be due to an action on the thyroid and parathyroid glands.

The record also indicates the importance of the study of the interdependence of various internal secretions. The manner in which the cellular constituents of the marrow had almost entirely disappeared from all the long bones in the case of No. 3, and to a less extent in No. 6, coincidently with the very remarkable hypertrophy of the thyroid and parathyroid glands, is extremely suggestive.

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6. LAWRASON BROWN.—American Journal of Medical Sciences, June, 1903, vol. cxxv, p. 1071.

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DISCUSSION.

The PRESIDENT asked Dr. Watson whether in any of the fowls he had made an examination of the excreta, and whether the renal function of fowls in eliminating uric acid was comparable with the renal function in man; whether he had reason for believing that a portion of the meat food given to the fowls had passed through the alimentary tract in a partially decomposed condition, as had been shown by Dr. Bardswell to occur in the human subject when an excess of meat food had been included in the dietary. Were there any signs of scurvy in the fowls? A certain increase in meat in the diet of tuberculous patients had been found useful, and raw meat was used much more extensively abroad than in this country; but any approach to an exclusive meat diet would presumably be detrimental, and the point to ascertain was what proportion of meat or raw meat food was useful for that omnivorous animal man under conditions of tuberculosis.

Mr. WALTER EDMUNDS, referring to the thyroid changes, said that, so far as he knew, this was the first time that there had been produced experimentally an enlargement corresponding to the enlarged thyroid which occurs in simple goitre, unaccompanied by symptoms other than those produced mechanically by the size of the tumour.

Dr. CHALMERS WATSON, in reply, said that the question of excretion had been carefully investigated by Kionka. He (the speaker) did not think it a promising line of investigation. There was good reason to believe that fowls had a similar capacity for dealing with an increased amount of uric acid to that which the human subject had for dealing with an excess of urea. An examination of the fæces did not indicate that the meat had passed through the alimentary tract in a partially decomposed state. There was no evidence of scurvy.

PROTRACTED AND RECRUDESCENT INFECTION IN DIPHTHERIA AND SCARLET FEVER

BY

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N.B.—*For Synopsis see page* 592.

THIS contribution is a clinical study of a number of cases occurring in my experience during the past ten years; and I propose first to describe the cases and outbreaks of disease illustrating protraction and recrudescence of infection in scarlet fever and diphtheria, commenting on each case in succession. There is ample material for one contribution in either of the diseases named, but I have preferred to discuss the two diseases together, one main object of this contribution being to bring out the close analogy between the two diseases and the similarity of the phenomena which they display.

Although the conceptions of protracted continuous infection and of recrudescent infection are separately stated, it is often impracticable to state to which group a given case may belong. The interval between the release from isolation of the infecting patient and the infection of the infected patient may be longer than the incubation period of the disease, owing either to lack of earlier opportunities

of contact or to a true interval of freedom from active infectivity on the part of the infecting patient.

Protracted Infection in Scarlet Fever.

Case 1.—J. I—, aged 4½, of No. 4 R— Road, was admitted to hospital on April 14th, on the third day of scarlet fever. Her temperature remained elevated for four days, and rose again after a day's interval. On April 22nd double otorrhœa began. There was slight nasal discharge on admission. Temperature fell to normal on April 26th, and remained so. On May 3rd it was noted that there was "no desquamation, and had been none except fine and powdery on body. Both ears and nostrils still discharging." On May 8th noted that "both ears still discharging; also nose. Suspicion of desquamation on feet." She was sent home on May 12th, after having been in the hospital twenty-nine days. There was then no desquamation.

This patient was treated throughout in one ward with six other patients, no other patients being admitted to this ward after April 26th. The following is a list of the patients who were in the same ward as the above patient during some portion of her stay in the hospital:

W. M—, aged 5, 16 K— Street. Admitted February 22nd, discharged April 14th. Had profuse nasal discharge on admission, which ceased about April 7th. Had some enlargement of cervical glands about March 31st.

F. M—, aged 10, 16 K— Street. Admitted April 26th, discharged June 10th. No septic complications.

D. M—, aged 3½, 13 C— Square. Admitted April 5th, discharged June 5th. No septic complications.

W. C—, aged 4, 39 H— Road. Admitted April 8th, discharged June 4th. Otorrhœa began April 15th. Much nasal discharge on May 3rd. Was in next bed to above patient J. I—.

F. C—, aged 2½, 39 H— Road. Admitted April 8th, discharged June 4th. Much nasal discharge on admission.

O. F—, aged 18, 10 L— Road. Admitted April 24th, discharged June 17th. No septic complications.

It is to be noted that J. I—, the patient in question, was admitted on April 14th to a well-ventilated, large ward, which during the whole of her stay in hospital did not contain more than six other patients. As no patients were admitted to the same ward during her convalescence,

the possibility of her receiving and storing in her nasal cavities auxiliary infection from other more acute patients is excluded. Of the patients admitted to this ward two besides herself had rhinorrhœa on admission, while three were and remained free from septic complications throughout. One of these was F. M—, a "return" case. W. C—, whose brother F. C— had nasal discharge on admission, began with otorrhœa a week after admission.

Before describing the course of events after J. I— was sent home it will be convenient to summarise the corresponding facts for the four of the above seven patients, in whose families no secondary or return cases occurred:

	Stay in hospital.	No. of susceptible persons in patient's home.
D. M— . . .	60 days	No children in this house.
W. C— and F. C—	56 days	Father, mother, and a child aged six months; have not had scarlet fever.
O. F— . . .	53 days	No children in this house.

CASE 1 (*continued*).—J. I— left the hospital prematurely on May 12th, after twenty-nine days' isolation. She had double rhinorrhœa and otorrhœa at this time. During the first week of her stay at home, she played with her brother during the day, but slept separately. On the nights of the 5th, 6th, and 7th of June she slept with her brother, B. F. I—, aged 3 yrs. 8 mos., and he failed with scarlet fever on June 8th. When admitted to hospital on the 10th he had rhinorrhœa, and next day there was left otorrhœa. On the 18th right otorrhœa began. On June 12th it was noted that there was a large amount of thin nasal discharge, and the upper lip was œdematous. A swab taken from the throat was regarded as suspicious of diphtheria, though the Neisser stain failed to confirm this suspicion. From this time until a week before leaving the hospital, he was kept in a separate small room, but was attended by the nurse who attended seven or eight other patients in the general ward. On July 8th it was noted that there was double otorrhœa, less rhinorrhœa. On this day the formalin nasal and throat douche (¼ per cent.), which had been given thrice daily since June 18th, was changed to Tinct. Iodi ʒij ad Oj. On July 25th the formalin was resumed. The mother was anxious to have the child home, and took him home on August 14th, sixty-five days after admission. B. F. I—

had been for eight weeks in a room alone, except during the last week of his stay in the hospital. During this week he was in the general ward, which at this time contained only one patient, a convalescent who was sent home on August 21st without any recurrence of infection. A child aged 2 years, who with the father and mother had hitherto escaped infection, was sent away to friends before B. F. I— went home, and remained from home for a couple of months. This child was at home when J. I—'s return home was followed by B. F. I—'s attack.

On August 23rd, Mrs. I—, aged 31, the mother of the two last patients, failed with scarlet fever, and was admitted to hospital on the 25th. Since B. F. I—'s return home, she had syringed out his ears daily as directed.

Mrs. I— attributed B. F. I—'s attack to infection by a pair of boots worn by J. I— during his illness. These **had been disinfected by soaking in a solution of lysol. They were played with and cut up by J. I— and B. F. I—. I incline to the view that both B. F. I—'s and Mrs. I—'s cases were true "return" cases. Taking this view, the following points of interest present themselves:**

1. Mrs. I— was not infected by J. I— on his return home, although she was apparently as much exposed to infection from him as was B. F. I—, who appears to have been infected by J. I— on or about the fifty-sixth day of his disease, *i.e.* about twenty-four days after he had been sent home on the thirty-second day of disease.

2. The child, aged two years, and J. I—'s father, who were also in close contact with J. I—, were not infected.

3. There was an interval of twenty-seven days between the day when J. I— left the hospital and the onset of B. F. I—'s attack, but the two did not sleep together until three days before the latter event.

4. Mrs. I—, who had escaped or successfully resisted infection for twenty-seven days or more from J. I—, was infected apparently by B. F. I— after only nine days' exposure to infection. There was no reason to believe that meanwhile she had deteriorated in health. Her husband (who has not had scarlet fever) remained well.

Thus Mrs. I— was probably exposed to infection on

three occasions, and only became infected on the third: (a) For three days before J. I—'s admission to hospital. (b) For twenty-seven days or longer from J. I— after his return home, and for three days from B. F. I— before admission to hospital. (c) For nine days from B. F. I— after his return home.

Why should Mrs. I— succumb to infection on this third exposure? Assuming that this was not mere accident it is desirable in attempting to answer this question to pursue our study of the patients who were in the same ward as B. F. I—.

B. F. I—, aged 3 yrs. 8 mos. Admitted June 10th, discharged August 14th. Had otorrhœa and rhinorrhœa when discharged, and continuously from day of or day after admission.

Mrs. I—, aged 31. Admitted August 25th, discharged October 4th. No complications.

During the week at the end of which B. F. I— was discharged, the only patients in the same large ward were:

(1) F. F—, aged 7½. Admitted on May 26th with chorea, scarlet fever, and eczema capitis. Discharged on August 21st.

(2) F. A—, aged 1 year 2 mos. Admitted July 10th with scarlet fever complicated by stomatitis. This was followed by pneumonia, and the patient died on August 8th, about the time when B. F. I. left his separate room.

Two brothers, Harry H—, aged 2½, and Hugh H—, aged 11 mos., were admitted on June 22nd with scarlet fever and whooping cough, and were therefore put in a separate room with separate nursing throughout. On admission both these children had greatly enlarged cervical glands, nasal discharge, and otorrhœa. These two patients are mentioned to indicate the then prevalent type of disease. There was no inter-communication between them and any other patients.

It may be added that every patient has a separate towel and comb and a separate syringe, the nozzle of which is kept by the bedside in lysol solution in the intervals of using.

Of the patients who were nursed along with one or other of the two children, J. I— and B. F. I—:

1. Of the total number (eight) four had septic complications (*i. e.* rhinorrhœa or otorrhœa or stomatitis or eczema) on admission. One (W. C—) apparently developed it later, but his sister had much rhinorrhœa when admitted on the same date as W. C—. Three other patients in the same ward had no septic complications throughout.

It is clear, therefore, that in nearly every instance the type of disease was determined before the patient's admission to hospital, by the previous environment of the patient, or by the condition of the patient's mucous membrane, or by the natural history of the disease, or by an undetermined combination of these and possibly other circumstances.

2. There was no overcrowding in the ward in which the above cases occurred. It was capable of accommodating sixteen patients, each having ample floor space.

3. The only circumstance pointing to the possibility of the scarlatinal contagium of B. F. I— being rendered more infective by hospital conditions consists in the presence of F. F— in the same ward, and this is not a sufficient explanation of the fact that B. F. I— infected his mother, while J. I— had not done so. The facts point to the view that the capacity to produce "return" cases in these instances was independent of the hospital conditions under which the patients were treated; and that the protracted and increasing infectivity of these cases was a phenomenon in the natural history of the disease, irrespective of their environment, and probably due to the then prevalent type of disease.

CASE 2.—W. M—, aged 5, of 16, K— Street, failed with scarlet fever on February 18th, and was admitted to hospital on February 22nd. On admission he had profuse nasal discharge, which ceased one week before he left the hospital on April 14th. On March 31st he had enlarged cervical glands.

On April 7th this patient's sister, F. M—, aged 9, complained of sore throat, but continued to attend school until April 23rd. She suffered from headache on April 24th, and on the 26th had a scarlatinal rash, twelve days after her brother's return home. In the same

house were the father and mother, and boys aged 15, 13, 5, and ½ year old respectively. None of these have had scarlet fever. F. M— had no mucous discharges or other complications during her attack of scarlet fever.

At the time when W. M— was sent home, there were in the same pavilion eleven other convalescent children. These children were as follows:

	Admitted.	On admission.
J. P.	Jan. 21st	Nasal discharge and enlarged glands.
C. F. and A. F.	Feb. 20th and 19th	No complications throughout.
E. S.	?	?
F. W.	Feb. 15th	No complications throughout.
H. K.	Feb. 17th	Enlarged glands.
Mrs. E.	Feb. 28th	No complications.
J. B.	March 1st	No complications.
R. D.	March 5th	Much nasal discharge. Otorrhœa later.
F. F.	March 17th	No complications.
C. L.	?	No complications.

In this instance also the rhinorrhœa, which is a common index of chronic infection, was present when the patient was admitted to hospital.

For four weeks before being sent home, the patient was in contact with none except convalescent cases, and in this, as in all the other instances recorded in this paper, the patient's nares were washed out twice daily during the whole of the convalescent stage with a 1 in 200 solution of lysol.

CASE 3.—F. N—, aged 3, of No. 2, E— Street, was admitted to hospital with scarlet fever on September 20th, and discharged on November 3rd. While in the hospital he had purulent nasal discharge, which was first noted two days after admission. On September 27th right otorrhœa began. When he was discharged he had a hard cough, but no rhinorrhœa or otorrhœa, and no roughness of skin. When examined on November 20th he was apparently in a normal condition. After leaving the hospital, F. N— slept in a separate bed for two nights, afterwards in the same bed as D. N—. There were in this house two families. Of the patient's family, the mother, a girl aged 10, and boys aged 8 and 1¾ years, who had not previously had scarlet fever, remained well. In the second family

the mother had scarlet fever some years ago, the father and a child, who had not had scarlet fever, remained well.

On November 11th, D. N—, aged 6 years, failed with scarlet fever, and was admitted to hospital on the 12th. This patient was in more intimate contact with F. N— than the rest of the family. He had attended school during the last three weeks before F. N— returned home, but during this time no cases of scarlet fever were notified among the children attending this school.

At the time when F. N— was sent home there were twenty-six other patients in the same pavilion, divided into two wards. Of this number, seven had no rhinorrhœa. Among the remainder, the following complications had existed:

	Admitted.	On admission.
A. B.	Sept. 15th	Earache, swollen glands, otorrhœa later.
D. D.	Sept. 19th	No rhinorrhœa; this began three days later.
B. W.	Sept. 19th	Rhinorrhœa and eczema.
D. W.	Sept. 19th	Rhinorrhœa and glands.
F. N.	Sept. 20th	Profuse rhinorrhœa two days after admission.
D. W.	Sept. 21st	Rhinorrhœa.
R. M.	Sept. 22nd	Ditto.
L. M.	Sept. 22nd	Rhinorrhœa and double otorrhœa.
K. M.	?	?
A. S.	?	Rhinorrhœa and double otorrhœa.
F. A.	Oct. 11th	Rhinorrhœa.
A. S.	Oct. 20th	Slight rhinorrhœa.
B. F.	Oct. 21st	Rhinorrhœa.
W. F.	Oct. 20th	Ditto.
F. F.	Oct. 24th	Ditto.
C. W.	Oct. 21st	Slight rhinorrhœa.
A. W.	Oct. 21st	Slight rhinorrhœa and otorrhœa.
E. W.	Oct. 21st	Slight rhinorrhœa.

At this time it will be noted that there was no separation between acute and convalescent cases. One patient had been admitted to the same pavilion within ten days of the time that F. N— was sent home. It should also be noted that of the cases in the ward when F. N— went home, while seven had no mucous discharges, eleven had been noted as having rhinorrhœa on admission, two rhinorrhœa and otorrhœa on admission, one rhinorrhœa three

days after admission, and one swollen glands on admission. This case, therefore, is open to the interpretation that the "return" case was caused by the accumulation of acute infective material from other patients in the nasal passages of F. N—. It is equally capable of explanation on the supposition that the persistence of infection was determined by the storing and probably the continued multiplication of personal infection in his mucous crypts and follicles, continuing in this instance in the absence of rhinorrhœa or otorrhœa.

In the following instance the source of infection appeared to be an otorrhœal discharge:

CASE 4.—E. H—, aged 5, of 36, L— Road, was discharged from a metropolitan fever hospital on October 22nd, having been there sixty-nine days with scarlet fever. She returned directly home to the above address, having otorrhœa at the time. This was attended to by the mother, Mrs. H—, aged 31, who failed with scarlet fever on October 25th. The note made on E. H—'s bed-ticket on October 20th was "Skin, mucous membrane, and urine normal."

The following hospital "return" case occurred in connection with a patient discharged from the Southampton isolation hospital:

CASE 5.—On July 6th, 1903, I received a letter from Dr. Lauder, the Medical Officer of Health of Southampton, stating that J. S—, aged 3, had been in his isolation hospital with scarlet fever for fifty-five days, and was discharged that day and going to a certain house in Brighton where his parents lived. He added "Yesterday I discovered some eczema behind his ears . . . . and I give you notice to this effect. I may say that on June 30th he was disinfected and put in a ward specially prepared, so that he has had a week away from infection. He will again be disinfected before discharge." The Brighton address given was unfortunately erroneous, and I could not find the child. He lived with his parents at 26, K— Street from the 7th to the 18th. They then removed to 41, C— Street, and from that time J. S— slept in the same bed as J. C—, aged 3, the landlady's child. J. C— failed with scarlet fever on July 20th, and was admitted to our sanatorium on July 22nd. His brother, N. C—, aged 2, failed with scarlet fever on July 28th. In a further letter Dr. Lauder informed me that J. S—, on the day he left hospital, "had a slight watery discharge from the nose."

In this instance the exceptional circumstance arose that I was warned by my *confrère* of the possibility that J. S— might still be infective, but was unable to trace his movements owing to a mistake in the supposed address.[1] J. C—, who slept with J. S—, was infected within two days of the first contact between the two, and nineteen days after J. S— had been removed from any source of infection except himself. There could, therefore, be no question of accumulation f infection from acute cases other than the patient himself, unless this accumulation persists much longer than has hitherto been supposed, and than can reasonably be supposed to occur. The more probable hypothesis is that J. S—, notwithstanding all the precautions taken, continued to harbour scarlatinal germs in the deeper parts of his naso-pharyngeal mucous membrane, or to act as an "incubating chamber" of them.

Obvious difficulties are presented in attempting to distinguish between recurrent infection caused by a return of infectivity which had previously become dormant, and persistent infection, which only waited for susceptible material to work upon. In the following instances there appears to have been *return of infectivity* after its temporary disappearance, as also in Case 1.

CASE 6.—X. B—, aged 6, failed with scarlet fever on September 10th; admitted to hospital September 12th; sent home on October 23rd. During his stay his temperature occasionally rose to 100° F., for which no cause could be detected. No mucous discharges. Hands and feet rough when sent home. Remained well until November 14th, when he had his hair cut. "Seemed to have a cold next day," and when seen by me on the 19th had a tickling cough, but no sore nose or mucous discharge. The sister, E. B—, aged 4½, failed with scarlet fever on November 17th.

It appears probable that although sixty-five days had elapsed since the onset of X. B—'s attack, twenty-three

[1] This case occurred during the time that Dr. Lauder was conducting an interesting experiment in treating convalescent and acute cases, complicated and uncomplicated cases in different wards. The details of the experiment are given in the 'Lancet,' March 12th, 1904, p. 712.

days had elapsed since he left the hospital, and thirty-five days had elapsed since he had been in contact with acute cases, recrudescence of lurking infection occurred, the exciting cause being the "cold" starting on November 14th.

This explanation is confirmed by the following two instances of "return" infection occurring in home practice during the same year as the last:

CASE 7.—G. U—, aged 5, failed with scarlet fever on August 1st at I—, was nursed at home and isolated until September 12th, when disinfection was carried out. This appears to have been drastic. She had ear discharge in the first week of her illness, not afterwards; no nose discharge. For the three weeks after September 12th G. U— and her sister, E. U—, played together, but did not sleep together. The family came to Brighton on October 1st. On the way down they stayed with a married sister, who had ten children all at home. These have remained well. After arrival in Brighton G. U— slept alone until October 10th. On this night she slept in the same bed with her mother and sister, and the latter failed with scarlet fever on October 12th. The reason for their sleeping in the same bed was that G. U— "appeared to have got a cold from a draught at the window and the rain coming in." No outside infection could be discovered.

CASE 8.—N. C—, aged 8, failed with scarlet fever on July 31st, at Y—. Disinfection carried out September 15th, there having been isolation for seven weeks. The disinfection appears to have been most thorough. Her sister, F. C—, and the above patient occupied the same bed at Y— from the 19th to 21st September inclusive. They then returned home together to H—, and still slept in one bed until October 14th, when they arrived in Brighton. On the day of arrival the sister, F. C—, aged 10, failed with scarlet fever.

In considering the origin of the preceding "return" cases several alternatives present themselves:

1. The case is a true "return" case.
2. Infection has been caused from the source which caused the first case in the household.
3. There has been failure of disinfection.
4. Missed cases explain the recurrence of infection.
5. Latent microbism (producing "carrier cases") explains this recurrence.
6. The infecting patient has had, while isolated, or

after release from isolation, a true relapse of scarlet fever, or an abortive relapse in the form of a scarlatinal sore throat, and has, owing to this being overlooked, been released prematurely from isolation.

The second of these alternatives can usually be excluded with some approach to exactitude. The third is more difficult, and involves a certain amount of error. Failure in a minute detail may involve recurrent infection, not infrequently near the time when the first patient returns home. This, however, is probably an exceptional occurrence. "Missed cases" are a much neglected source of recurrent infection. Nor as a matter of coincidence is it surprising that a certain number of instances of "missed cases" should infect others about the time of the return of the first patient from hospital. Diphtheritic infection may persist for several months in an apparently healthy nasopharynx, and it is not surprising that this occasionally happens in scarlet fever. The following case possibly comes under this head. It illustrates the occurrence of what would, if the first patient had been sent home after the usual period of isolation, have been regarded as a "return" case.

CASE 9.—D. J—, aged 7½, failed with scarlet fever on December 14th; was admitted to hospital on December 16th. Her attack was complicated by peri- and endocarditis, and she had not returned home on February 5th, when the brother, J. J—, aged 2½, failed with scarlet fever, fifty-one days after his sister's removal. There are also in the same house a baby aged ten months and the father and mother, none of whom have had scarlet fever, and all of whom remain well. The father is a coachman, and the family live in rooms over the coach-house. J. J— is a rachitic child. He has not been out of the house since D. J—'s removal, and no visitors have been in the house. No outside source of infection could be discovered. Disinfection had apparently been rigidly carried out, and inquiries, when the second case occurred, failed to reveal any carelessness.

Latent microbism is another explanation of such cases. The following cases possibly come under this head:

CASE 10.—G. R—, aged 5, failed with scarlet fever on December

6th, removed to hospital December 8th. F. R—, aged 7, failed with scarlet fever December 25th, removed December 26th. K. R—, aged 4, failed January 7th. There were no other children in this house. Father and mother had no sore throat or other symptoms. Thus secondary cases occurred at intervals of eighteen and fourteen days respectively. No outside infection after the first case. Disinfection very thorough.

CASE 11.—B. C—, aged 5, failed with scarlet fever on September 24th, admitted to hospital September 29th. H. C—, aged 4, failed with scarlet fever October 13th. Is stated to have "had a cold" all the time since the removal of B. C—. When seen by me on September 30th had a "stuffy nose." A brother, aged 8, remained well; father and mother same. Interval of fifteen days between the two cases. Disinfection thorough.

CASE 12.—O. D—, aged 9, failed with scarlet fever September 21st, admitted to hospital September 23rd. B. D—, aged 6, failed with scarlet fever October 6th, thirteen days interval. In this and the above cases, no evidence of further outside infection. B. D— stated to be "poorly" when O. D— was removed.

These cases may be explicable like Case 9, on the supposition that there was a "missed case," *i. e.* a case in which although there were symptoms, *e. g.* a scarlatinal sore throat, these symptoms were unrecognisable or unrecognised. It is possible, however, that they are to be regarded as "carrier cases," *i. e.* instances of patients who harbour scarlatinal germs on or in their mucous membranes for a considerable time; these only eventually "taking root" if or when a catarrh or some other condition lowers resistance to infection. We know that such cases occur in diphtheria. Why not also in scarlet fever?

In other cases recurrence of infection in the household to which the patient belongs is due to the patient suffering from a relapse of scarlet fever during convalescence or after release from isolation. The following case deals with the second of these possibilities:

CASE 13.—B. F—, aged 12, fell ill on November 1st, with vomiting and sore throat, and on admission to hospital on November 4th there was a well-marked scarlatinal rash. The attack pursued a

normal course, there being no nasal or aural discharge. She returned home on December 20th, having been in hospital forty-nine days. On the 23rd she was re-admitted to the scarlet fever ward on the certificate of a different doctor from the one who notified her first attack. It was stated that she was quite well on the previous evening, but the scarlatinal rash was noticed on the morning of admission. She had had a gum-boil two days previously. The temperature was normal on re-admission, and remained so. She had a slight sore throat. The rash was scarlatiniform. There were enlarged post-cervical glands, and the possibility of rötheln was considered. This was, however, excluded at the time, and no subsequent cases of rötheln occurred in this ward. On January 9th she had joint pains, but no elevation of temperature. There was no rhinorrhœa or otorrhœa while in the hospital, but she had some soreness of the septum naris, which was apparently well when she left the hospital on February 10th. When the two next cases were notified B. F—'s nose was again found to be sore. C. F—, aged 8, failed with scarlet fever on February 18th. D. F—, aged 10, failed with scarlet fever on February 20th.

There appears to be no doubt that they were infected by B. F—. Assuming this to be the fact, these two sisters (the only susceptible persons in the house) escaped infection on two occasions—(1) in the days preceding B. F—'s removal to hospital with her first attack; (2) in the day preceding B. F—'s removal with her second attack or relapse of scarlet fever.

Several explanations of the earlier escape and the final sickening with scarlet fever of C. F— and D. F— suggest themselves: (a) The earlier escape may have been merely accidental; this is unlikely. (b) Their resistance to infection became almost simultaneously lowered at a later date, which is also unlikely. (c) A more infective type of scarlet fever capable of infecting previously insusceptible subjects was bred, not in a second patient, but in the same patient, who had previously suffered from a presumably less infective type of that disease. If this last hypothesis be accepted, what caused B. F— to be more infective in her second than in her first attack? The following facts as to the hospital circumstances under

which B. F— was treated during each attack of scarlet fever are here inserted in view of their possible bearing on the problem.

During the last seventeen days of B. F—'s first stay in hospital, except the last three days, she was in a corrugated iron building, having a partition 6 ft. 6 in. high between its two halves, the convalescent patients being on one side and the acute patients on the other side of the partition. The last three days B. F— was in a separate room before she left the hospital. The following figures include the patients on each side of the above partition. Fourteen patients were in the same ward when B. F— was discharged, and seven others had been discharged during the previous fortnight. Of these twenty-one patients five had been in the hospital less than three weeks, one only one week. One other patient, admitted October 28th, had a relapse on December 4th.

During B. F—'s second stay in hospital she spent a considerable part of her time in a separate small room, possibly the whole time, though this cannot be definitely stated, as the record is incomplete on this point. Assuming, however, that she was at least occasionally in contact with the patients in the general ward, we may note that nineteen patients were in this ward when B. F— was finally discharged, and three had been discharged during the previous fortnight. Of these twenty-two patients ten had been in the hospital less than three weeks, four of them less than two weeks.

Thus there were ten acute cases in the general ward, from which she was finally discharged, as compared with five when she was discharged in the first instance. Against this is to be set the fact that B. F— was kept partially or entirely in a separate room, and was certainly discharged after being isolated at least three days in this room.

The greater infectivity of the relapse was in my judgment a cycle in the life-history of the contagion totally unconnected with hospital conditions. I also regard the relapse as self-generated. (On this point see page 588.)

Protracted Infection in Diphtheria.

It is unnecessary to enumerate a large number of instances, as prolonged infectivity in this disease is well

recognised. The two following instances dealing with localised outbreaks of diphtheria bring out the close analogy between diphtheria and scarlet fever in regard to protracted infection :

Case Group 14.—Mrs. W—, aged 27, failed with diphtheria on November 15th, 1903, and was admitted to hospital on November 18th. There were living in this house two families, as follows :— Mrs. E. W—, Mr. W—, Thomas W—, aged 3, baby, aged 5 months; Mr. H—, Mrs. H—, A. H—, aged 10, G. H—, aged 8, C. H—, aged 5, D. H—, aged 3, E. H—, aged 1 year 8 months.

C. H—, aged 5, failed with a second attack of diphtheria on November 20th; admitted to hospital on November 21st. No history of school infection. G. H—, aged 8, failed with diphtheria on November 22nd; admitted to hospital on November 23rd. Investigation of the household drew suspicion to Thomas W—, aged 3. A nasal swab was taken from him on November 23rd and showed diphtheria bacilli, and he was admitted to hospital the same day. On admission he had eczema naris extending over face. December 7th, throat swab positive; December 15th, throat swab negative; December 16th, nose swab positive; December 20th, noted that slight rhinorrhœa continues; December 21st, eczema below lobe of right ear; December 28th, no nasal discharge; December 30th, nose swab positive, throat swab negative: A culture from the nose swab was sent to Dr. Eyre, Guy's Hospital. He reported that he isolated the diphtheria bacillus from a sub-culture on blood serum and cultivated it in a parallel series with a true *Bac. diphtheriæ*, and then inoculated it into the subcutaneous tissue of 250 gramme guinea-pigs, with a fatal result within forty-eight and seventy-two hours respectively. It was further found that 1 c.c. of a filtered three-day old broth culture would kill a guinea-pig of 250 grams weight. The simultaneous injection of 1,000 units of diphtheria antitoxin neutralised the toxin and prevented any ill-effects on other guinea-pigs of similar weight.

On January 7th, 1904, throat swab was again positive; next day the same, but no growth in the nose swab. January 22nd, no nasal discharge for five days and no sore places. January 24th, nose and throat swab both negative. January 25th, nose swab positive, throat swab negative. February 7th, nose swab positive, throat swab negative. February 10th, still thick purulent discharge from the nose when syringed. At the end of March consistent negative swabs were obtained, and shortly afterwards he was sent home.

The previous history of Thomas W—, kindly furnished by Mr. A. J. Hutchison, Surgeon to the Brighton Throat and Ear Hospital,

has important bearings on his protracted infectivity. He first attended this hospital on December 29th, 1902, with a history that he had had right otorrhœa since the age of four days. On examination, pus was found in the right ear and in both nasal fossæ. The tonsils were enlarged, and there were adenoids. The child improved under treatment, the ear discharge having ceased and the nose discharge diminished by January 5th, 1903. January 12th noted that ear and nose both dry. January 26th, nasal discharge had reappeared. Something unusual was noticed about the appearance of the nose at this time, and on January 28th the nose was probed for a foreign body under an anæsthetic, but none found, and at the same time tonsillotomy done and adenoids removed. On February 5th noted that the child breathed quietly through the nose. The child was not seen again at the Throat Hospital until November 5th. Then the history was given that he had been well until a month previously, when he complained of pain in the back of the head, return of discharge from nose, but not from ear; has had several fits. Not seen by Mr. Hutchison after this. On November 23rd, as noted above, he was admitted to the Isolation Hospital, though showing no ordinary clinical evidence of diphtheria.

	Onset diphtheria.	Removed to hospital.
Geo. W—, aged 12, 43 X— St.	Oct. 17th, 1902	Oct. 17th, 1902
Thomas W—, aged 3, 39 X— St.	?	Nov. 23rd, 1903
C. H—, aged 5, 39 X— St.	May 4th, 1903	May 16th, 1903
D. H—, aged 3, 39 X— St.	(Bacteriological case, discovered May 23rd)	
R. D—, aged 4, 41 X— St.	Oct. 23rd, 1903	Home treated. Positive nasal swab until Jan. 30th
N. D—, aged 3, 41 X— St.	Nov. 13th, 1903	Nov. 21st, 1903
Mrs. W—, aged 27, 39 X— St.	Nov. 15th, 1903	Nov. 18th, 1903
C. H—,[1] aged 5, 39 X— St.	Nov. 20th, 1903	Nov. 21st, 1903
G. H—, aged 8, 39 X— St.	Nov. 22nd, 1903	Nov. 23rd, 1903

There had, as shown in the preceding tabular statement, been diphtheria in this same house in May, 1903. C. H—, aged 5, failed with diphtheria on May 4th; there was no history of school infection or of cases in the vicinity. D. H—, aged 3, was swabbed (nasal) on May 23rd, and diphtheria bacilli found. Instructions were given for her isolation at home as a "contact" case.

Two doors from the above house lived R. D—, aged 4, who played with Thomas W— on October 20th. (No school infection.) A few

[1] Second attack.

days later he is said to have had "sore thumbs," but no history of sore throat. On November 9th he was taken as an out-patient to a general hospital because he seemed languid and out of sorts and had swollen cervical glands. He again attended the same hospital on November 16th. Meanwhile his sister, N. D—, aged 3, failed with diphtheria on November 13th. N. D—'s notification on November 22nd led us to swab R. D—'s throat on November 23rd, with a negative result. A nasal swab next day was positive. R. D— remained at home, and was swabbed at intervals. A throat swab on January 30th was still positive, *i. e.* 102 days after apparently the only contact with infection, and 82 days after he was being attended by a doctor for enlarged cervical glands.

The question arises what was the true order of events, and how far was Thomas W— responsible for them?

Further light is thrown on the problem by the history of a household living four doors away, who were an visiting terms at the time the following case occurred, but ceased to intermingle afterwards in consequence of a quarrel. This was a family of cousins, consisting of father and mother and four children, and a second family, consisting of two adults and an infant. Geo. W—, aged 12, in the cousin's family, failed with diphtheria on October 17th, 1902, and was removed to hospital the same day. No other cases followed.

It is conceivable that Thomas W— acquired nasal diphtheria at this time, but did not infect any one among the two families living at No. 39 until May 4th, 1903, when C. H— failed with her first attack, and D. H—followed with a non-clinical attack; that R. D—, and secondarily N. D—, were also infected by Thomas W— in October, 1903, his own mother on November 15th, and C. H— a second time on November 20th.

Compare with the above possibility the history of Thomas W—'s septic nose and ear.

Thomas W—.	Patients possibly infecting or infected by Thomas W—.
Right ear discharge from a few days after birth.	
	Cousin and neighbour, George W—, failed with diphtheria, Oct. 17th, 1902.

Thomas W—.	Patients possibly infecting or infected by Thomas W—.
Dec. 29th, 1902.—First examined. Right ear purulent and both nasal fossæ, enlarged tonsils and adenoids.	
Jan. 12th, 1903.—Both ear and nose dry.	
Jan. 26th, 1903.—Nasal discharge had reappeared.	
Jan. 28th, 1903.—Adenoids and tonsils removed.	
Feb. 5th, 1903. — Breathing nasally. Said to have been free from discharge from February to beginning of October.	
	Lodger's child failed with diphtheria, May 4th, 1903. Sister of this child a "contact" case.
Did not attend Throat Hospital again until Nov. 5th, 1903. Now stated to have had return of rhinorrhœa since about Oct. 5th.	
	Another neighbour's child failed with diphtheria, Oct. 23rd, 1903.
	A second child in same family failed with diphtheria, Nov. 13th, 1903.
	Mother of *Thomas W*— failed with diphtheria, Nov. 15th, 1903.
	Lodger's child failed with second attack of diphtheria, Nov. 20th, 1903, and another child in the same family on Nov. 22nd, 1903.

The above facts are quite consistent with the view that Thomas W—, in October, 1902, received from his cousin the infection of diphtheria, which was grafted on the chronic septic condition of his nose without causing any obvious symptoms of diphtheria; that this infection became quiescent, but that in May, 1903, when Thomas W— was not under medical observation, he infected the lodger's child; and that in October, 1903, when he is known to

have had a recrudescence of purulent nasal discharge, he infected a neighbour's child, with whom he played. On November 15th, while still being treated for rhinorrhœa, he infected his mother, and a few days later re-infected the same lodger's child as before. It is even possible that Thomas W— was infected with diphtheria at an earlier date, and that he gave this disease to his cousin G. W—.

Incidentally the case illustrates the importance of careful and repeated bacteriological examination of purulent nasal discharges. It is further noteworthy that R. D— at home, and Thomas W— first at home and later in hospital, were persistently infectious, the first for over 100 days, the latter probably much longer than this. Although Thomas W— received nasal syringing with various germicidal solutions twice daily during the whole time he was in hospital, diphtheria bacilli did not fail to reappear in the nasal discharge two or three days after the syringing was discontinued.

The following cases, like Group 14, illustrate protracted infectivity in diphtheria under circumstances rendering the explanation that this was caused by hospital aggregation inadmissible. They appear also to illustrate the simultaneous protracted infectivity of scarlet fever and diphtheria in the same patients, though the proof of this as regards scarlet fever is incomplete.

Case Group 15.—William F—, aged 2¾, of 10, I— Cottages, failed with diphtheria on July 14th, 1902, and was admitted to hospital on the 16th. On admission he had considerable exudate on fauces, and his nostrils were blocked (8000 antitoxin given). Next day there was some epistaxis and the breath was foul. On the 19th throat exudate had gone, but there was still nasal discharge. On August 3rd it was noted that there was regurgitation, and this was marked for three days about August 27th. On August 30th a negative bacteriological result was obtained from swabbing. On September 12th noted that no regurgitation for several days, and no nasal discharge. On September 15th a second negative swab was obtained, and the patient went home next day. No desquamation was discovered in this patient although frequently looked for in connection with the suspicion aroused by the next case.

Grace F—, aged 4¼, sister of the above, failed with diphtheria on July 17th, and was admitted to hospital on the same day. On admission only a slight white exudate was found, but next day diphtheria bacilli were detected. On July 31st she had a rash, with pain in ankles, and a temperature not over 98·8°. This rash was ascribed to the 4000 units antitoxin she had on admission. On August 6th desquamation on the hands and feet was noticed, "pin-hole" in character, and fairly extensive. The mother stated at this time that the child had "measles" twice within the last year, the last time said to be "three or four months ago," since when she had noticed the child's hands peeling on several occasions. On August 9th, 10th, 15th, and 17th, consecutive bacteriological examination of swabs failed to detect diphtheria bacilli. The patient went home on August 19th. She had no nasal discharge throughout. She was again medically examined on August 28th, and was then quite well, there being no desquamation and no ear or nose discharge.

The family from which the above patients came consists, in addition to the above patients, of father, mother, and girls aged 13, 10, and 8, who have never had diphtheria.

The two above children on July 31st were put into a small room adjoining the main diphtheria ward, owing to the suspicion attaching to Grace F—'s rash. William F— never desquamated, and when his sister was sent home on August 19th he was allowed to return to the diphtheria ward. Four cases of scarlet fever shortly afterwards occurred in this ward.

	Admitted with diphtheria.	Onset with scarlet fever.
D. C—, aged 6 . .	August 1st .	August 22nd.
B. C—, aged 4 . .	July 31st .	August 22nd.
D. F—, aged 1 yr. 10 mos. .	July 28th .	August 23rd.
W. W—, aged 6 . .	July 31st .	August 22nd.

My deputy, who was then on duty, appears to have used every reasonable precaution in regard to Grace F—, the balance of available evidence being against the supposition that her desquamation was due to scarlet fever. It is possible that one of the above four attacks was a relapse of scarlet fever, for both B. C— and D. F— had evanescent rashes on admission. Such rashes may be caused by the administration of antitoxin, but they may also be due to very slight scarlet fever. There were twelve patients in this diphtheria ward; no further cases of scarlet fever occurred. The above patients were at once transferred to a separate ward, and William F— was placed with them. He did not develop scarlet fever while with them. He was sent home on September 16th, after two consecutive negative

swabs had been obtained, and after remaining in hospital sixty-one days. It will be noted that from July 16th to 31st he was in the general diphtheria ward with ten to twelve other patients. From August 1st to 19th he was in a detached room with his sister. From August 19th to 23rd he was again in the general diphtheria ward; and from that time until sent home on September 16th he was in a separate pavilion with one or more of the above four patients suffering from scarlet fever and diphtheria.

Subsequent events showed that this patient's infection recrudesced after leaving the hospital, as shown by the following cases in the same and an adjoining small street, which there is reason to suspect were infected by him:

	Left hospital.	Re-admitted to hospital.
Grace F—, æt. 4½	Aug. 19th	Oct. 4th.
William F—, aged 2¾	Sept. 16th	Oct. 4th.

	Onset of diphtheria.
Louisa M—, aged 1, of 3, I— Cottages	Sept. 19th.
George M—, aged 3, of 3, I— Cottages	Sept. 30th.
William T—, aged 4, of 7, I— Cottages	Sept. 22nd.
J. G. C—, aged 2½, of 6, T— Street	Oct. 4th.
Mrs. C—, aged 32, of 6, T— Street	Oct. 8th.

The occurrence of the first of the cases in these three neighbouring houses led us to re-examine William and Grace F—, and both children were now found to have eczema naris, Grace having thin watery discharge, and William thick yellow discharge from the nostrils. A nasal swab from William on October 2nd showed diphtheria bacilli; confirmed by the Neisser test. The following further bacteriological examinations were made:

Date of test.	William F—.	Grace F—.
Oct. 2nd	Positive (nose)	—
Oct. 4th	Negative (throat and nose)	Positive (nose) confirmed by Neisser. Negative (throat).
Oct. 29th	Negative (nose)	Positive (nose), a pure culture of long variety, and note made that nasal discharge now thick yellow.
Nov. 2nd	Negative (throat)	Positive (throat), negative (nose).
Nov. 19th	Negative.	—

On November 5th a specimen from Grace F—'s throat was sent to the Jenner Institute, and Dr. MacFadyean reported that "diphtheria

bacilli were isolated, which were found to be pathogenic to guinea-pigs."

William F— was allowed to return home on November 22nd after several negative swabs. Grace F— was kept in hospital until December 16th, the swabs not being satisfactory, although characteristic diphtheria bacilli were not discovered after November 5th.

It is somewhat difficult to give the correct interpretation of the course of events in the preceding cases. Was Grace F— re-infected when her brother returned home on September 16th, or was she infectious before this? More probably the latter view is correct. If so, the infection of diphtheria persisted in an overt or covert form in this case from July 17th to November 5th at least—*i. e.* 110 days, probably longer. As during the last nineteen out of her thirty-two days' stay in hospital she was in a separate room with her brother, this persistence of infection cannot be regarded as due to any unfavourable hospital influence. There is the further fact that she was suspected of causing through her brother a small outbreak of scarlet fever in the diphtheria ward. I believe that she had suffered some time previously from scarlet fever (called "measles") and that the infection of this disease, like that of diphtheria, assumed a chronic form, both infections persisting in her nasal passages.

If this view be correct why did she not infect the children in the general ward with scarlet fever between July 17th and 31st? At this time she was kept in bed, which would go far to explain immunity from cross-infection, contained *ex hypothesi* in her nasal mucous membrane. If it be assumed that the slight rash on July 31st was the commencement of her scarlet fever we have to face the difficulty that some undetected source of scarlet fever must have been present in this ward, and this only began to operate and then operated almost simultaneously on four patients, three days after W. F—'s return to the general ward. The progress of Grace F—'s desquamation does not fit in with this supposition. There can, I think, be little doubt that W. F— caused the out-

break of scarlet fever in the general ward when he returned to it on August 19th convalescent and was not kept in bed. But he had not been known to have scarlet fever. It is probable, therefore, that he, like Grace F—, was harbouring a persistent form of scarlatinal infection in his nose. He almost certainly was immune against further scarlet fever, as from August 23rd to September 16th he was treated along with four scarlatinal patients without developing an attack.

In the preceding instances there was protracted infection before hospital isolation was secured and in hospital (in Thomas W—, Case 14), in a patient who was never treated for diphtheria (R. D—, Case 14), and in William and Grace F— (Case 15), who were isolated in hospital under conditions which rendered it highly improbable that they would subsequently harbour the diphtheria bacilli from other patients than themselves.

In the following instance, a patient who had clinical diphtheria, but in whose exudate Klebs-Loeffler bacilli could not be found, was infectious for 170 days, if the view taken as to the cause of the cases shown in the scheme on the next page be correct.

CASE 16.—B. G—, aged 4, failed with diphtheria on August 19th, admitted to hospital on the 25th. On admission, moderate exudate on tonsils. No diphtheria bacilli found. A second negative swab on the 26th. On September 5th Hofmann bacilli found; on September 6th no diphtheria bacilli found. The child returned home on September 7th, directions being given that she was not to resume school attendance for six weeks from the following Monday.

B. G— resumed attendance in the Babies' Class of —— School on September 24th, contrary to directions. This class and the Fourth Class of the same school have a common cloak-room. On September 26th W. M—, aged 3, failed with diphtheria in the Babies' Class, and on October 3rd H. W—, aged 5, failed with the same disease in the Fourth Class. Diphtheria bacilli were found in each of these. No actual contact between these children and B. G— could be proved. It was now discovered that B. G— had improperly resumed attendance at school. A swab was taken from her throat with a negative result. She was quite well, and had no nasal discharge.

B. G—, aged 4, of 27, D— Street.
Onset diphtheria Aug. 19th.
Hospital Aug. 25th, slight throat exudate on admission.
Four negative swabs.
Sent home Sept. 7th.
Resumed school attendance (Babies' Class) Sept. 24th.

W. M—, aged 3, of 6, T— Street.
Onset diphtheria Sept. 26th.
Last attendance (Babies' Class) Sept. 25th.
Diphtheria bacilli present.

H. W—, aged 5, G— Street.
Onset diphtheria Oct. 3rd.
Last attendance (4th Class) Oct. 1st.
Diphtheria bacilli present.

B. G—, *negative swab* Oct. 7th.
Returned to school Jan. 25th until Feb. 5th.
Negative swab Feb. 12th.

O. S—, aged 2 11/12, of 18, R— Street.
"Cold" Feb. 9th.
Seen by a doctor Feb. 10th.
Away from school (Babies' Class) Feb. 9th to 22nd, except 2 half-days, Feb. 16th and 17th.
Examined Feb. 23rd, large cervical glands and
Diphtheria bacilli present.

F. D—, aged 3, of 18, S— Street.
Onset diphtheria Feb. 2nd.
Last at school (Babies' Class) Feb. 3rd.
Diphtheria bacilli present.

B. N—, aged 4, of 34, M— Street.
Onset diphtheria Feb. 6th.
Last attendance school (Babies' Class) Feb. 5th.
Diphtheria bacilli present.

F. S—, aged 6, of 18, R— Street.
Onset diphtheria Feb. 18th.
Hospital Feb. 22nd.
Diphtheria bacilli present.

B. S—, aged 10, of 18, R— Street.
Onset diphtheria Feb. 21st.
Hospital Feb. 22nd.
Diphtheria bacilli present.

G. S—, aged 1.
Onset diphtheria about Feb. 20th.
Diphtheria bacilli present.

G. B—, aged 5¼.
"Bronchitis" Dec. 10th.
"Cold on chest" Jan. 26th.
Nasal discharge Feb. 7th.
Hospital Feb. 10th.
Numerous *consistent negative swabs* after admission.
Nasal voice a fortnight after admission.

B. G— did not again attend school until January 25th of the following year, attending until February 5th. The following cases occurred in the same class at this school: F. D—, aged 3, onset February 2nd; O. S—, aged 3, onset February 9th, and B. U—, aged 4, onset February 6th. Diphtheria bacilli were found in each of these. No other likely sources of infection for the above children were discovered except B. G—, and as on the first occasion further cases abruptly ceased when B. G— was again excluded from school. Three secondary cases occurred in O. S—'s family.

B. G—'s family consists of father and mother, boy aged 5, and a child aged 2½ years. These have all remained well, except that the child aged 2½ had "a cold" on February 3rd, when a negative swab was obtained from him, and a negative swab once more from B. G—.

In the same house lives another family consisting of father and mother, a child aged 2, who had bronchitis near Christmas, and a boy, G. B—, aged 5½, who had "bronchitis", beginning about December 10th, had again a "cold on his chest" onset January 26th, nasal discharge beginning February 7th, seen by a doctor on February 10th, and notified as diphtheria the same day. No diphtheria bacilli were found in his nasal or throat secretions, although these were examined repeatedly after his admission to hospital. He was very pallid, and a fortnight after admission developed a nasal voice.

In the following instance a similar sequence of events occurred, but the connection of F. M— with F. S—'s attack was confirmed by finding diphtheria bacilli in F. M—'s throat fifty-three days after she had been discharged from hospital on the strength of three consecutive negative swabs. It should here be stated that, with the exceptions noted in the accounts of cases, negative results have not been accepted unless they have been repeated on three days, and unless on each of these days the specimens have given a negative result, both with methylene blue and with Neisser stain.

CASE 17.—F. M—, aged 10, failed with diphtheria on November 19th; admitted to hospital on November 20th. Infected at school. Had pharyngeal diphtheria; no nasal discharge. Three consecutive negative swabs were obtained from her throat on December 14th, 15th, and 16th, and she was discharged on the 17th.

In the same family were father and mother, and two sisters, aged 8 and 7, none of whom had diphtheria. The two sisters returned to

school on December 20th. The ex-patient returned to school on February 1st, six weeks after leaving hospital, in accordance with our usual procedure.

F. S—, who is in the same class with F. M— at school, failed with diphtheria on February 4th. No other cases occurred in this class, and no other source of infection for F. S—'s attack could be discovered. Suspicion being directed to F. M—, a swab was taken from her throat on February 8th, with a positive result. She was carefully examined and found to have no nasal discharge, and had been quite well since returning home. Her two sisters have slept in the same bed with her since the week before Christmas. On February 10th swabs were taken from the three sisters again, with a negative result in each case.

In neither of the preceding cases was there nasal discharge or any other symptom leading one to suspect the possibility of continuance of infectivity.

This is a convenient opportunity for alluding to protracted infectivity in ear discharges, which I do not remember to have seen mentioned in connection with diphtheria. It is probably more frequent than has hitherto been recognised, though in diphtheria, as in scarlet fever, persistent ear discharges are less likely to be actively infective than throat and nasal discharges, owing to the absence of coughing and sneezing from the infecting surface.

CASE 18 (*simulating a "return" case*).—N. B—, aged 5, failed with diphtheria on February 5th; admitted to hospital February 10th and discharged March 18th. She slept at home this night in a separate bed, and next morning was taken to another town, returning home on March 28th. On March 25th K. N—, aged 2, a step-sister of the above, failed with diphtheria, and it was suspected that she might be a "return" case. The above dates, however, do not fit in with this supposition, and the following appears to be the probable source of K. N—'s infection. The baby brother of N. B—, aged 9 months, began with discharging ear on or about February 24th, a fortnight after N. B—'s admission to hospital. When K. N— failed with diphtheria this baby's ear was examined, and a pure culture of diphtheria bacilli obtained by cultivation of the discharge on blood serum.

CASE 19.—K. S—, aged 4, was infected with diphtheria at ——— School, and failed on November 14th. He was admitted to hospital

15th and discharged on December 21st, after three negative swabs from the throat. Immediately after mission to hospital the brother, D. S—, aged 4, and S—, aged 1, were given prophylactic doses of antitoxic At this time a swab from D. S.—'s throat gave a negative —, while in hospital, had left otorrhœa, which began th, and on December 11th had ceased. He had profuse ge on admission, but this had ceased when he went otorrhœa returned after he came home. He occupied a oom, but played with D. S— and W. S— during the remained well, but on January 3rd, fourteen days — came home, D. S— failed with diphtheria, and was to hospital next day. R. S— was now re-examined and e anæmic, and still had left otorrhœa. A swab from the January 5th showed diphtheria bacilli.

—D. R—, aged 1 year, failed with diphtheria on November tted to hospital on November 18th with pharyngeal and ntheria. On November 28th right otorrhœa began; on er 9th there was double otorrhœa and some evidence of eal paralysis. On 31st December a negative swab was rom the throat, but the discharge from both ears showed bacilli. On January 5th throat and ear swabs all negative. On January 7th throat swab negative. January 9th throat swab negative, ear swab growth too scant for diagnosis. January 11th swabs from both ears negative; only very slight ear discharge and no nasal discharge. The patient was sent home on January 12th. The serum-growth taken on the 31st December was tested by Dr. Eyre, and found to be virulent.

Instances have been given of scarlet fever occurring in households at intervals after the removal of the first patient to an isolation hospital beyond the ordinary incubation period. A similar sequence is not uncommon in diphtheria, but it is unnecessary to quote cases.

Summary of Conclusions.

The preceding instances suffice to suggest, and in some respects to elucidate, some of the most important points in connection with cases of protracted and recrudescent infection. These will be next considered before discussing in further detail the same problems in relation to the hospital or home treatment of these diseases.

Firstly, it must be borne in mind that cases of protracted and recrudescent infection are relatively infrequent, representing only a very small percentage of the total cases of these two diseases. For many years I have acted in the dual capacity of medical officer of health and medical superintendent of the fever hospital in a town in which nearly every case of scarlet fever and diphtheria has been personally investigated, and have therefore viewed the problem from both standpoints. The number of "return" cases is small and not such as seriously to invalidate the enormous benefit which patients and their friends receive from the hospital, even if it be assumed that "return" cases are special hospital phenomena.

Secondly, cases of protracted and recrudescent infection are oftenest associated with nasal and aural discharges, though not always so. The proportion between "return" cases in which such discharges have been present and those in which they have been absent cannot be stated in the absence of statistics of the most accurate and detailed description on a large scale, the data for which do not at present exist. In my experience the proportion in which there are no mucous discharges is small, but their occurrence is undoubted.

Thirdly, the absence of this information indicates the necessity for accurate records both in hospital and home practice of all cases of protracted and recrudescent infection, and the following schedule is suggested as embodying the minimum information which ought to be obtained in every such case. Similar information should be available for our entire experience of scarlet fever and diphtheria, in order that trustworthy comparisons may be instituted.

Scarlet Fever.

Schedule of Information as to Cases of Recurrent Infection.

(A)—1. Name and age of infecting patient.
2. Day of disease on which patient admitted to hospital.
3. Name of hospital.

4. Date of onset of following complications if present
   (1) Ear discharge.
   (2) Nasal discharge.
   (3) Any eczematous condition.
   (4) Enlarged cervical glands.
5. Last date on which these symptoms were present:
   (1) Ear discharge.
   (2) Nasal discharge.
   (3) Any eczematous condition.
   (4) Enlarged cervical glands.
6. Date of leaving hospital.
7. Method of discharging from hospital.
8. Number of patients in the ward from which —— was discharged.
9. How many of these had been in the hospital three weeks or under?
10. How many of these had any of the above complications (1) (2) (3) (4) at the time —— was discharged?

(B)—*The infected patient.*

1. Date of onset of attack.
2. Age and name of patient.
3. Character and extent of contact between B and A.

(A similar sheet with obvious alterations for home cases.)

Fourthly, the occasional occurrence of such "return" cases emphasises the necessity for post-isolation supervision of patients, whether treated at home or in hospital. This supervision must necessarily be medical; and as most patients are poor, it can only be carried out officially. Short of systematic medical supervision much may be done by warning parents as to precautionary measures, and by communicating with the doctor who first notified the case.

In Brighton scarlatinal patients are not permitted to return to school until four weeks, and diphtheria patients not until six weeks after they have been released from home or hospital isolation. This is in the interest of the convalescent patients; also in the interest of others in the event of the patient being one of the exceptional "chronics" who form the subject of this paper.

Fifthly, a study of the preceding cases indicates that in most instances the rhinorrhœa, which is oftener than any

other morbid condition associated with protracted infection, was already present when the patient was first isolated, or appeared soon afterwards. This fact has an important, and hitherto neglected, bearing on the origin of "return" cases. It suggests the belief that a condition determining protracted infectivity may have been similarly present from the first in the infecting patients,[1] in whom no obvious mucous discharge occurred.

Sixthly, if it be assumed that a morbid condition of the naso-pharynx is a necessary condition of protracted infectivity, do this morbid mucous membrane and its crypts act as a continuing incubator of scarlatinal or diphtherial germs originating from those which caused the patient's illness, or do they act merely as a suitable storehouse for germs derived from other acute patients in the same room —a storehouse which can only be emptied by one or more weeks' absence from acute patients? This point will be discussed more fully later. As bearing on it, I need only say here that instances have been given in the preceding pages of protracted infection in which the infecting patients had been in contact with acute cases (Case 3), in which there had been no such contact (Cases 2, 5, 15), and of home-treated cases in which this cause of secondary infection is excluded (Cases 7, 8, and 14).[2]

Seventhly, there is definite evidence that in some instances infection has become dormant, to be again roused into activity by various circumstances, as by the disturbance caused by cessation of isolation, possibly in connection with baths at the time of discharge, or at a later period by a catarrh or other means tending to lower personal resistance.

Eighthly, the cases bring out the close analogy between the phenomena of protracted and recrudescent infection in scarlet fever and in diphtheria. (1) In both diseases

[1] Patients causing "return" cases are "infecting patients." Patients infected by these are "return" cases.

[2] Numerous instances of "return" cases in home practice are recorded in the medical journals, *e. g.* 'Lancet,' August 25th, 1877, p. 300; also in Dr. E. Squire's 'Collected Essays in Preventive Medicine.'

infection is occasionally exceptionally prolonged. The percentage of "return" cases in most statistics is stated to be much lower in diphtheria. We have no certain knowledge how long the scarlatinal germ will survive in the naso-pharynx, though probably in exceptional instances quite as long as the diphtheria bacillus (see Case Groups 14 and 15). From a clinical standpoint it must, I think, be regarded as still an open question whether protracted infectivity is more common in one of these diseases than in the other. Considerations arising from the absence of bacteriological diagnosis in scarlet fever, the necessity for making inoculation experiments to test the virulence of diphtheria bacilli, and above all from the incompleteness of our observations, especially in regard to home-treated cases, are sufficiently obvious. (2) In both diseases infection occasionally recrudesces. This may occur (a) in the form of a definite relapse having all the **clinical features of the disease in question; but more commonly (b) the only accompaniment of recrudescent infection is the recurrence of a mucous discharge, and even this** indication of the possibility of recrudescence may be absent.

Explanation of Protracted Infectivity.

The persistence of active and the occasional recrudescence of dormant infection may be compared with corresponding phenomena in ringworm. Most cases of scarlet fever or diphtheria are like tinea of the face or body—the contagium quickly disappears. The exceptional cases are like tinea capitis. No difficulty arises in destroying the contagium on the scalp surface, but it reappears with the growth of the hairs from their follicles. And this comparison incidentally furnishes what is, I believe, the correct view of the causation of persistence of infection in scarlet fever and diphtheria. The specific micro-organisms of these diseases remain in crypts of the naso-pharynx, which act as active "incubators" of them. This applies to the cases continuously infectious. In those cases in which

infection temporarily disappears, to recur under the influence of a catarrh or some traumatism, etc., it may be supposed that the specific micro-organisms have been lodged and at least partly incarcerated in the follicles, and possibly in deeper lymphatic tissues or glands. The occasional protracted persistence of the Klebs-Loeffler bacillus in the throats of certain healthy individuals who have been in contact with diphtheria and in the throats of convalescents from this disease is well known. Cases 14, 15, 16, 17, 18, 19, and 20 illustrate these facts. Mr. Jonathan Hutchinson, F.R.S.,[1] has observed:

"Upon our knowledge in respect to the possible latency of germs will often depend the measures which we take for the prevention of infection. . . . It may be, indeed, that a very large fallacy underlies much of our present creed as to infection, and that in many instances what we attribute to fresh infection is really consequent upon some change in the conditions of the subject which have favoured the development of pre-existing germs."

Diphtheria forms an excellent example of this contention. My experience has been that it is especially in the very mild attacks of diphtheria that it is difficult to secure within a reasonable time freedom from infection as tested by bacteriological standards. The brothers and sisters of cases of clinical diphtheria, who have apparently had nothing beyond nasal catarrh or a non-membranous sore throat, appear to retain diphtheria bacilli in the naso-pharynx longer than the marked cases even when subjected to the same local treatment. Professor Theobald Smith has pointed out that the invading micro-organisms, in their struggle for existence, are liable to be put at a disadvantage by an excess of virulence, just as in a bacteriological culture the products of metabolism of the micro-organisms appear to retard or inhibit the growth. A patient may, owing to the natural antitoxic properties of his tissues, aided by the further antitoxic strength acquired

[1] "The Latency of Parasitic Germs or Specific Poisons in Animal Tissues," 'Proc. Roy. Med. and Chir. Society of London,' November 26th, 1895.

during the very slight attack which he has had, continue to harbour, without further harm to himself, diphtheria bacilli which are competent to produce severe disease in more susceptible persons. This is well seen in Thomas W—'s case (Case 14), and probably such cases are much more numerous than is at present realised. The facts as to protracted scarlet fever are not so well recognised, but exactly the same phenomena occur in this disease as in diphtheria. In each disease the morbid phenomena are the resultant of the interaction of the micro-organism and the patient. If the latter is only slightly susceptible, or if he is insusceptible, the micro-organism is not necessarily destroyed, but may continue to exist in a virulent form on or in the mucous membranes of the resistent person, and may be capable of conveying virulent infection to others.

The conception of protracted infection in diphtheria is not novel. Thus Greenhow in 1860 said,[1] "Unlike scarlet fever, which is always an acute disease, running a very definite course, diphtheria is sometimes of protracted duration, and occasionally becomes almost chronic." Evidently Greenhow, like many others, while recognising the persistent form of diphtheria, had overlooked the persistent form of the more widely prevalent disease, scarlet fever. Gresswell in 1886[2] brought forward certain facts "which appear to show that diphtheria in certain individuals may become a chronic disease, and from time to time enter upon an active and infectious phase; and that this may play an important part in maintaining the malady in a community." He gave a number of instances of persons who "having been affected with diphtheria years ago have suffered almost constantly ever since with throat affection and acute tonsillitis on exposure to change of weather, and diphtheria has occurred among those who associate with persons suffering from this condition."

I have carefully read the scanty details of his cases, and cannot find that in any of them there was nasal discharge.

[1] "On Diphtheria," by E. H. Greenhow, M.D., p. 110.

[2] "Diphtheria as a Chronic Malady in Particular Individuals with Liability to Recrudescence," by D. A. Gresswell, B.A., M.B. ('Epidem. Soc. Trans.,' p. 57, new series, vol. v).

The cases furthermore occurred before bacteriological confirmation of diagnosis was practicable. In one case the inference is drawn that if the sequence of events is correct "a person once infected with diphtheria, may remain capable of transmitting infection for a period of nearly two years." This fact need not cause surprise in view of the history of Thomas W— (page 564).

Hospital Treatment in Relation to "Return" Cases.

In the preceding pages, instances have been given of protracted infection in scarlet fever in which there had been no recent contact with acute cases of that disease, and of cases in which there had been no contact during the patient's illness with any except personal infection; and it has been shown that in some of these cases infection recrudesced after an interval of apparent freedom from infection.

It has also been shown that such instances of protracted and recrudescent infection occur in diphtheria when patients are treated at home; and in this disease, no suggestion, so far as I am aware, has been made or could be supported, of any special hospital influence favouring "return" cases. The known close relationship and analogy between the two diseases suggests that the explanation of the above occurrences for one disease will apply equally for the other.

How do these facts and considerations bear on the suggestion that the occasional persistence of infection in scarlet fever is due to hospital infection? The aggregation of cases in hospital wards has been widely taught to be the cause of "return" cases in scarlet fever. Dr. Niven for instance, has described such cases as "a hospital phenomenon,"[1] and he was the first to recommend the

[1] In a letter to me he states "by 'return' cases being a hospital phenomenon, I go beyond the facts and make an inference, viz. that something happens at the hospital which does not happen at home. This something was, as far as I could judge, storage of fresh infectious matter

separate treatment of convalescent and acute cases of scarlet fever. Whatever view be taken of the origin of "return" cases, the desirability on general grounds of such separate treatment of acute and convalescent cases is undoubted.

In view of the preceding facts and considerations, I maintain that in scarlet fever, as in diphtheria, the occasional persistence of infection is a phenomenon in the natural history of the disease, irrespective of and in the main uninfluenced by the external conditions to which patients are ordinarily subjected. This view (a) is not contradicted by the statistical evidence as to the excess of "return" cases in hospital experience; and (b) it is strongly confirmed by the facts and considerations already advanced; (c) by the facts as to relapses in scarlet fever; and (d) by the analogous facts as to protracted infection in other infectious diseases besides scarlet fever and diphtheria.

Statistical Evidence.—Statistical evidence supports the view that "return" cases occur in disproportionate numbers in connection with hospital-treated cases of scarlet fever. But it needs to be remembered that the number of "return" cases in any experience is relatively small, and that home-treated cases have not hitherto been rigidly investigated in regard to "return" infection. It is known

in the nostrils as the result of the presence of acute cases in the same ward. It is not intended to deny that the infective element of scarlet fever remains viable in the case discharged from hospital, or that it has lost all power of infectivity, but it is suggested that the strains of infectious material foreign to the individual when stored up in his nasal cavities remain less impaired by the action of his tissues than the infective material peculiar to himself." For particulars of the facts on which he bases this conclusion, see Dr. Niven's 'Annual Reports' from 1891 onwards. Professor W. J. R. Simpson in his report (1899) to the Metropolitan Asylums Board on "Return Cases of Scarlet Fever and Diphtheria" evidently takes a somewhat similar view, as he concludes that "long detention in infective wards will not reduce the percentage of return cases," and that "local and antiseptic treatment combined with transference to less infective wards are likely to be more effective in this direction" (page 24).

that from 1 to 4 per cent. of "return" cases ordinarily occur after hospital treatment of scarlet fever. When home-treated "return" cases have occurred, they have commonly been ascribed to failure of disinfection rather than, as in hospital cases, to persistent or recrudescent personal infection. I am at present totally unable to accept as satisfactory the statistical evidence that "return" cases are a special hospital phenomenon. It has to be remembered that home-treated cases are picked cases, allowed to be treated at home, because there were no susceptible children in the same house, or because the home conditions as to isolation and cleanliness were good. Before any accurate conclusions can be drawn, it will be necessary to know both for hospital and for home-treated cases of scarlet fever, the number, age, and sex, of all the persons in the same household not previously having had scarlet fever, and to state the incidence of recurrent infection with due regard to these facts.[1]

One statistical reason for the under-statement of home-treated "return" cases is illustrated by Cases 7 and 8. A considerable proportion of the total home-treated cases are furnished by families in easy circumstances, with whom change of air during convalescence is a matter of routine.

Even if it be ultimately found that there is a real excess of "return" cases in connection with the hospital treatment of scarlet fever, the facts already recorded, showing (a) that "return" cases occur when single cases are treated at home (Cases 7 and 8), and (b) that they occur in hospital-treated patients for whom either the conditions of home treatment have been secured or for whom separate treatment in convalescent wards has been secured (Cases 1, 2, 5), indicate that "return" cases are not essentially hospital phenomena, *i. e.* that treatment alongside of other acute scarlatinal patients is not the

[1] Some statistics on these lines are given in my 'Annual Reports' for 1901 and 1902; and Dr. Malet has compiled similar statistics for Wolverhampton.

unconditional invariable antecedent of protracted or recrudescent infection. Consequently hospital treatment is degraded to the position of a non-essential concomitant, at the most an auxiliary, of such infection.

The Causation of Septic Complications.—The excess of "return" cases in hospital practice does not prove that hospital aggregation of patients is even an auxiliary in producing such "return" cases. The possibility of *non cæteris paribus* has to be borne in mind.

It needs to be remembered that (1) the homes of the poor from which the hospital cases come are often dirty, the patients' nasal passages are exceptionally septic or sepsigenic from the beginning, the infection of scarlet fever opening up the way for septic complications in connection with which the contagium of scarlet fever is able to enjoy a protracted life. (2) The poor are less resistent to the inroads of combined scarlatinal and septic infection than the well-to-do who are better nourished. The mouth and naso-pharynx contain various micro-organisms, which on the occurrence of scarlet fever set up secondary mischief and are responsible for the otitis, rhinitis, and other septic phenomena of scarlet fever. These septic organisms are present when the patient is admitted.[1]

The whole question of the origin of these septic discharges is raised by the problem of "return" cases. It can, I think, be elucidated by our knowledge of what occurs in allied conditions. We know the influence of a wound or other form of injury in favouring the origin of scarlet fever. Scarlet fever occurs in scalded children, in whom no possibility of recent external infection can be detected.[2]

[1] Compare Dr. Washbourn's statement, "During an attack of scarlet fever the resistance of the body is lowered, and the previously latent streptococci begin to multiply and invade the body, producing various septic troubles" ('Proc. Roy. Med. and Chir. Soc.,' November 26th, 1895, p. 44).

[2] On this point I may quote the 'Med. Mag.' (May, 1902, p. 327), which refers to articles by Dr. Lippmann in the 'Wiener Klinische Rundschau,' for April 6th, 13th, and 17th, 1902. "Dr. Lippmann's attention was attracted to the subject by two curious cases of recurrent

It is probable that under such circumstances a dose of the scarlatinal virus which would ordinarily be inoperative, is able to cause this disease; and that such smaller doses are more often harboured by children than is usually believed. Similarly we know that every naso-pharynx contains sepsigenic cocci. We also know that in a large proportion and probably in most of the scarlatinal cases manifesting rhinorrhœa who are treated in hospital, the rhinorrhœa is present when the patient is admitted to hospital. Is it more reasonable to assume that in the remaining hospital patients who begin with rhinorrhœa at a later period of their isolation, this is due to external infection or as in the former to secondary self-infection?

If it be not some condition peculiar to certain patients which render them capable of causing "return" cases, the same capacity might reasonably be expected to show itself in a large majority of the patients in the ward after their return home. This special condition must be either a condition of the mucous membrane enabling the scarlatinal germs to continue to live and propagate, or the presence of a race of germs capable of exceptional length of life. It is more in accordance with the clinical facts to suppose that the scarlatinal germs multiplying and collecting in the patient's own mucous membrane will be in larger numbers and will be more efficient to produce secondary infection than the relatively minute number which can

scarlatina. In the first case the patient had been well for a month with the exception of an enlarged left cervical gland. 'Urged by the mother to do something for it, I advised oatmeal poultices, which were diligently applied. On the second day I was called to the patient, and found him with a relapse of the scarlatina, the enlarged gland having disappeared within thirty-six hours.' In the second case, a box on the left ear started a regular attack of scarlatina, beginning with sore throat on the left side in a boy who had had the disease twice within the last six and a quarter years. No external source of infection could be discovered, and Dr. Lippmann considers it was a case of 'traumatic scarlatina,' the blow setting free germs which had remained dormant or encapsuled for years. He has collected a large number of similar instances from medical literature."

obtain ingress from without. In short, the theory that contact with other scarlatinal patients causes to an appreciable extent increased and protracted infectivity is not, in my opinion, based on facts. It would be interesting to trace the origin of such a theory. Probably it owes its currency to the analogy with the brilliant work of Mr. Power, F.R.S., on the aërial convection of smallpox. The distal aërial convection of the contagium of this disease appeared to occur particularly when there was a certain accumulation of acute cases in the wards of the smallpox hospital. Under these conditions the carrying power of the disease appeared to be magnified. It is doubtful, however, if the theory of distal aërial convection of smallpox will survive; and, if not, with it will probably die the **theory (a theory to support a theory) that aggregation of acute cases of smallpox (and by analogy of other infectious diseases) tends to increase their infectivity. Such aggravation of infectivity is, in my opinion, more likely to occur in the houses of the poor than in the airy and cross-ventilated wards of an isolation hospital; and when it** occurs is, I maintain, part of the cycle of a given epidemic, and not the result of aggregation of acute cases.

Relapses in Scarlet Fever.—Relapses occur in a disease in which complete immunity has not been secured by the first attack. They are frequent in enteric fever, not uncommon in diphtheria, occur probably less frequently in scarlet fever, and are almost unknown in smallpox.[1] According to Dr. Caiger, a true relapse of scarlet fever occurred in ·7 per cent. amongst 12,000 cases observed.[2] In 1,520 cases under my own observation, sixteen relapses occurred, *i. e.* in about 1 per cent., the interval between the onset of the first and second attacks being 33, 32, 27, 66, 19, 38, 54, 35, 11, 38, 27, 40, 39, 37, 38, and 15 days respectively.

Now if it be contended that protracted infection in

[1] I have, however, reported one case of this, and collected several others ('Brit. Med. Journ.,' October 10th, 1896, p. 1032).

[2] 'Allbutt's System,' vol. ii, p. 162.

scarlet fever is a hospital phenomenon and caused by the storage of infection from other acute cases, it is reasonable to suppose that relapses of scarlet fever are also due to fresh infection from acute cases of scarlet fever. Compare on this point relapses in enteric fever. In a well-regulated typhoid ward there is practically no opportunity for a patient to be re-infected *ab extra*. It must be assumed, therefore, that relapse in enteric fever is nearly always due to self-infection. According to Murchison, relapses occur in 3 per cent., according to Griesinger in 6 per cent., and according to Shattock in over 16 per cent. of the total cases.[1] If relapses occur so frequently and with such varying frequency in a disease in which self-infection is practically the only operative cause of a relapse, can the occasional relapses in scarlet fever be ascribed with probability to external infection? True, in this disease, infection may be present on the floors, etc., of the hospital ward. But large doses of self-produced scarlatinal germs have recently been and probably are still *in situ* at the points where scarlatinal infection first takes root; and even if these germs be less numerous than those derived from other patients, they may reasonably be expected to be as much more potent than the floating infection *ab extra*, as is the hypodermic injection of a specific contagium than the ordinary infection *per os*. Not only is the self-produced contagium closer to the point at which it can grow, but there is every reason to believe it is much greater in amount than any contagium capable of being derived from other patients.

We know that occasionally relapses of scarlet fever occur in houses in which only one case of scarlet fever is being nursed. Here external re-infection from other patients is excluded. The conclusion is almost inevitable that relapses of scarlet fever are due to the revival of the infection which caused the original attack.

The occurrence and frequency of such relapses in enteric fever is determined by the type of each epidemic, and by

[1] 'Allbutt's System of Medicine,' vol. i, p. 831.

conditions personal in or to the patient, and not chiefly by his treatment, certainly not by conditions external to the patient. In measles and diphtheria the same remark holds good. So also in influenza, which might be taken as a type of the diseases which tend to relapse, and apart from a definite relapse to recrudesce.

There is reason to believe that the degree of immunity conferred by an attack of scarlet fever is greater when this is severe. In Brighton the fatality of hospital-treated cases of this disease in the years 1898 to 1901 was 1·3 per cent., in London in the same years 3·4 per cent., and the figures already given as to relapses, although on too small a scale to warrant a positive conclusion, are not inconsistent with the view that this is actually the case.

From relapses we may extend the inquiry to protracted or recrudescent infection without a definite relapse.

Protracted infection in scarlet fever.—Here, again, much light is thrown on the problem by comparison with other infective diseases. Diphtheria frequently manifests protracted infectivity in home-treated cases. We know also that the Eberth bacillus may persist for many months in the gall-bladder in periosteal abscesses (ten months after an attack of enteric fever), etc. There is no suggestion in this disease of renewed doses of external infection. Why then should the view that the occasional protracted infectivity of scarlatinal patients is caused by repeated doses of infection from without be entertained?

In influenza the possibility that relapses and recrudescence of infection may be due to external infection from other patients will often be tenable, in view of the fact that this disease usually runs rapidly through a family. But the influence of hospitalism cannot be urged; furthermore, all the available evidence tends to show that the contagium of this disease, like that of measles, is very short-lived when exposed to desiccation and the influence of light and air. In this disease, therefore, as in the others, the most reasonable hypothesis is that relapse and recrudescence of infection are due to the revived activity

of specific micro-organisms stored in the patient himself, and derived from his own initial attack; relapse or recrudescence being brought about by some factor which temporarily removes or reduces the slight degree of immunity already established.

It is unnecessary further to summarise the converging lines of evidence given in this contribution, which appear to me irresistibly to necessitate the inference that protracted and recrudescent infection when they occur in scarlet fever, are due, as in diphtheria, in enteric fever, and in other infectious diseases, to the prevalence of a particular type of disease and to conditions inherent in the patient himself, and not to any conditions, whether hospitalism or other, external to the patient.

I may, however, in conclusion mention one additional line of evidence to which, I think, some weight should be attached. It has long been accepted and taught by the medical profession that the desquamating is the most infectious stage of scarlet fever, and it is now very difficult to unteach the public this erroneous view. Such a general consensus of medical opinion in the past can scarcely have obtained vogue without having a body of evidence in its favour. We now know that desquamating patients may, as a rule, safely be sent home in the sixth, or even the fifth week of their attack of scarlet fever if they have no mucous complications. Some other cause must, therefore, have given rise to the widespread conviction that cases of scarlet fever were frequently infectious to the very end of desquamation. Such cases really occurred or the conviction would not have arisen. Doubtless they were the cases of persistent or recrudescent infection which now exercise our minds in relation to hospital administration. But when this conviction was formulated there were no isolation hospitals for scarlet fever. It is unnecessary to re-state the conclusion to which these considerations compel us, a conclusion which considerations from every point of view confirm and strengthen.

SYNOPSIS.

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   Case 1.—Hospital case: no recent contact of infecting case with other acute cases.
   „ 2.—Do.: do.
   „ 3.—Do.: contact of infecting case with other acute cases.
   „ 4.—Do.: hospital conditions unknown.
   „ 5.—Do.: no recent contact with other acute cases.
   „ 6.—Do.: recrudescent infection associated with a catarrh.
   „ 7.—Home treated case.
   „ 8.—Do.

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   „ 10.—Do.
   „ 11.—Do.
   „ 12.—Do.
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   „ „ 15.—Mixed infection of scarlet fever and diphtheria.
   „ 16.—Duration of infection probably 160 days.
   „ 17. „ „ 81 days.
   „ 18.—Infection in otorrhœa.
   „ 19. „ „ 52 days after onset of illness.
   „ 20. „ „ 43 „ „
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   (2) It is oftenest associated with rhinorrhœa and otorrhœa, but not always.
   (3) Accurate records of such cases are most desirable.
   (4) Post-isolation medical supervision of patients is required.

PAGE

(5) The complication with which recurrent infection is most often associated is commonly already present when the patient is first isolated.
(6) Is the morbid mucous membrane of the patient a storer of other patients' infection, or an incubator of self-produced infection?
(7) Dormant infection is sometimes rendered active after long intervals by catarrhs, etc.
(8) There is a close analogy between the phenomena of recurrent infection in diphtheria and scarlet fever.

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DISCUSSION

Dr. E. W. Goodall said that by those who were connected with infectious diseases hospitals many cases of protracted infection could be recounted similar to those described in the paper. It was well known that if, during convalescence from diphtheria, a patient contracted scarlet fever or measles, there was great probability of the recrudescence of the diphtheria. The Asylums Board had been investigating the subject for two or three years; and instances of protracted infection, from the evidence already collected, were communicated. The protracted infectiousness was not in his opinion due to hospitalism. Information was wanted as to the frequency of return cases in private practice. It was almost certain that desquamation was not a dangerous source of infection, if a source at all. The special cases associated with protracted infection were those with discharges from nose and ears, and also with secondary inflammation of the throat. Of 369 cases recently under his care 316 were mild, and of these two alone died from complications, namely nephritis; 24 per cent. of the mild cases had some complication on admission, such as some discharge; this was rhinorrhœa in 15 per cent., and 14 per cent. more got it while in hospital. In septic cases complications were more common. It was not infrequent to find in connection with return cases that a rhinorrhœa might come on for the first time after the patient had left hospital. He had met with mild cases of scarlet fever developing into severe ones while under strict isolation. It might be that ordinary streptococci might set up inflammation of the mucous membranes, and so light up the virus proper. It was probable that the discharges were more than mere carriers of the infection. Return cases were more common from hospitals for acute cases than from the convalescent hospitals. Reference was made to the French method of placing each patient in a closed glass cubicle.

Dr. P. Caldwell Smith said that the separation of acute and convalescent cases was carried out in Glasgow for many years. In 1902 he had a percentage of 4·5, and last year of 6·2 return cases, and in a large number of these there was no clear evidence of mucous discharges. Among a series of 1600 cases of scarlet fever he had met with only one home return case, but 400 only were treated at home. There was need for active measures to avoid the frequent occurrence of return cases.

Professor W. J. R. Simpson did not believe that protracted infection was part of the natural history of these diseases.

There were many sources of infection to be eliminated before falling back on this hypothesis. It was necessary, for example, to inquire into the conditions of the hospitals, especially in respect of isolating patients in large wards, or into the circumstances of the home when the patient was treated at home. In the cubicles of the infectious hospital attached to the Pasteur Institute in Paris disinfection of the surroundings was exercised every day; in the hospitals in London it appeared to be carried out once or twice a year. The effect of aggregation of infectious cases was illustrated by plague cases in South Africa, in which the severity of the disease seemed to be intensified when the ward was overcrowded, and decreased when the cases were treated in tents.

Dr. W. BUTLER said that the question whether return cases of scarlet fever were due to hospitalism or not was one of great importance from a public standpoint. He himself was quite persuaded that hospitalism was inadequate to account for return cases; the attendants on the patients did not carry infection. During the last two years he had kept records of houses where two or more cases succeeded each other in the same house. He found that among cases nursed at home with secondary notifications occurring beyond the incubation period, the intervals between the receipt of the primary and secondary notifications were respectively: 53 days, 14, 15, 73, 20, 135, 83, 36, 10, 9, 10, 18, 10, 9, 142, 10, 30, and 20 days. He had also found that a convalescent home into which only uncomplicated cases were taken was even a more fruitful source of return cases than the hospital for acute and complicated cases from which the cases were removed. The incidence of return cases seemed in this series to depend on driving convalescent patients home in the winter in an open vehicle, thereby, as it seemed, setting up catarrh subsequent to discharge from hospital, with an apparently consequent renewal of infectiousness. It seemed not possible to fix a time when infection after scarlet fever ceased. Desquamation, like adenitis, rhinitis, and any other of the pathological processes associated with the disease, was an evidence of activity of the scarlatinal poison and primâ facie ground for the view that if the virus is still capable of setting up a pathological process in the patient it is still capable, also, of setting up a similar process in another not already immune.

Dr. D. L. THOMAS said that he had investigated outbreaks for the London School Board, and, in regard to diphtheria, most of the return cases had never been near an infectious hospital. One case of infection lasting 120 days was described from which many cases arose. One lesson clearly taught by the paper was that the responsibility of the sanitary officer did not cease with the time the patient left the hospital. Another lesson was, that in regard to school closure it was necessary to

swab the throats of all the children and make systematic bacteriological examinations.

Dr. W. A. Bond said that last year (1903) there were in Holborn only 144 notifications of scarlet fever, and secondary cases occurred in only twelve houses, in only three of which they were probably true "return" cases. At the Metropolitan Asylums Board Hospitals in 1898 as many as 12·57 per cent. of the scarlet fever patients suffered from co-existent infectious diseases during their stay in hospital. Strict isolation of the patients should be aimed at on the lines of the hospital at the Pasteur Institute, Paris.

Dr. Newsholme, in reply, said that it was important to know when rhinorrhœa in hospital began, and when it ceased. Probably it was impossible to prevent a certain number of return cases, whatever precautions were taken. The Paris expedient was impracticable in regard to large cities. In 98 per cent. of the cases ordinary hospital treatment was efficient.

ON A
CASE OF PROPERITONEAL HERNIA

BY

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In Vol. LXXXII of this Society's 'Transactions' my colleague, Mr. G. H. Makins, has recorded a case of prevesical hernia, and in the differentiation of that particular form reference is made to a somewhat allied condition, properitoneal hernia.

It is now my privilege to bring before you a typical case of this rather rare variety, which contrasts well with Mr. Makins's.

The following are the details of my case:

Sydney W—, aged 54, a waterside labourer, was admitted into St. Thomas's Hospital on January 20th, 1901, under the care of my colleague, Dr. Acland. Of his previous history there is little to say beyond the fact that a left inguinal hernia had been present for many years, for which a truss had been worn; whether it was strictly "congenital" (*i. e.* existed from birth) could not be stated.

The hernia apparently had been kept up by the truss, and there had never previously been any trouble.

Until January 17th the bowels had been quite regular; on the 18th there had been no action, and on the 19th a very small motion was passed. From this time there had been no further passage of fæces or of flatus. The same morning he was sick for the first time and continued being so, vomiting eight times during the day, the vomit gradually becoming darker and offensive. On the 20th sickness was almost constant, and was now accompanied by severe abdominal pain. He was brought up to the hospital in the evening and admitted.

Examination showed his abdomen to be greatly distended, but moving with respiration. The abdominal wall was fairly flaccid, and there was no definite tenderness anywhere. The percussion note was tympanitic, the liver dulness being partially encroached on by the distended intestines; there was no dulness in the flanks. Nothing abnormal could be felt *per rectum*. Both inguinal canals were free of any hernial tumour, and "both testes were normally placed." The tongue was furred and moist. The vomit was dark bile-stained, but not particularly offensive. The pulse was 88 and regular, without much tension; and the temperature was 99·6° F. Two enemata were given with very scanty result. As the patient was evidently suffering from intestinal obstruction, I was asked to see him, and decided on immediate operation.

After the administration of chloroform further palpation of the belly showed some increased resistance on deep pressure just above the pubes on the left side, but this had no ascertainable connection with the inguinal canal, which seemed quite empty, although not abnormally so.

A vertical incision, about 3½ inches long, was made in the median line below the umbilicus. A loop of small gut and matted omentum were found entering through a small opening into a pouch situated behind the left abdominal wall and to the side of the bladder. As the edge of the opening constricted tightly the contents of the sac,

its margin was nicked, and the congested matted omentum was able to be withdrawn, but not so the bowel; on introducing the finger into the sac by the side of the gut, the latter seemed firmly adherent in front over the situation of the internal ring. As the state of affairs present seemed related to his hernia I opened up the inguinal canal in the usual way from the front, and found an empty peritoneal sac. On following this up to the internal ring there was seen presenting in the opening itself, but not projecting through it, bowel, which was firmly adherent, quite black, and lacerated easily on attempted separation. It was evident then that the bowel occupied, and was strangulated in, a pouch behind the abdominal wall; also that the loop of bowel occupying the aforesaid pouch had become gangrenous and was adherent to the sac. I then adopted what seemed the only available method. Having packed round the internal opening and further enlarged it, I separated the adherent loop from the sac, withdrew it through the internal opening, and brought it out externally through the abdominal wound. The bowel for 4½ inches was gangrenous, due to the severe constriction at the opening into the peritoneal cavity. This portion of the bowel with its corresponding wedge of mesentery was excised, and an end-to-end junction was made; a fine silk running stitch through all the coats approximated the ends, and a second securing row of Lembert's sutures was passed through the sero-muscular coats. As the condition of the patient did not allow of any delay the sac itself was thoroughly washed out but not excised; a gauze drain was placed down to the internal ring, and both the abdominal and inguinal wounds were sutured up. Infusion of normal saline was done into the median-basilic vein with temporary recovery, but he collapsed about one hour after the operation and died somewhat suddenly in the early morning of the 21st.

In the afternoon of the same day an autopsy was made, and nothing was found to note beyond the local structural

changes connected with the hernia; these, on careful dissection, have proved as follows, and may be seen in the specimen. The inguinal sac extends down the canal to just below the external ring; it is in the substance of the cord, the pampiniform plexus being in front and to the outer or left side of the sac, while the vas deferens, with its closely related vessels, is behind and to the inner side. The testis was normally placed in the scrotum. This inguinal sac has a comparatively small opening at the situation of the internal ring into the sac placed behind the abdominal wall. This inner sac is of an oval form with its long axis parallel with the direction of Poupart's ligament; it is markedly convex posteriorly and measures in its long axis 4½ inches, and in its transverse axis 2¼ inches. Its inner end is closely placed to the left side of the bladder, the lower and inner part of the sac being within the pelvis and in relation in front with the horizontal ramus of the pubes. In the inner third of the upper half of the sac posteriorly is a circular opening, of about one inch diameter, with a very sharply defined margin; this opening corresponds in front with the outer edge of the lower part of the rectus. On the outer side the sac extends into the iliac fossa, resting on and just passing beyond the external iliac vessels; the deep circumflex iliac vessels are to be seen coursing round the outer pole of the sac as they make their way outwards. The sac has an opening in front through which it is continuous with the sac in the inguinal canal—the two forming a bilocular cavity. This anterior opening is placed at the junction of the outer and middle thirds of the sac and to the outside of the deep epigastric artery. Just to the inner side of the internal opening is a small fold of peritoneum passing over the sac to the side of the bladder; this does not, however, appear to be related with the course of the obliterated hypogastric artery. To the inner side of the upper part of the sac is a very small peritoneal fossa—an observation of importance bearing in mind the views of Bär, to be referred to later. From the lower part

of the back of the sac another peritoneal fold is seen passing to the sigmoid loop running just external to the true brim of the pelvis.

The case just described is a well-marked example of properitoneal hernia, to which form our attention was first especially drawn in the able papers of Krönlein (v. Langenbeck's 'Archiv,' Bd. xix, 1876, and Bd. xxv, 1880), and subsequently by Breiter.

Its important anatomical feature is that it consists of a biloculated sac, of which the lower loculus is in the inguinal canal and may or may not extend into the scrotum; this pouch at the level of the internal ring opens into a second sac, which is placed behind the transversalis fascia in the subperitoneal connective tissue. This deep sac communicates with the peritoneal cavity by a round or oval opening placed either behind the normal position of the internal ring or more frequently to the inner side of the latter.

This feature of loculation of the hernial sac is common to many forms, and has led to many terms being employed by writers, some of which denote similar conditions, while others express very slight differences; again, very dissimilar conditions have been confused and grouped together under one heading.

In dealing with cases of biloculated hernia in the inguinal region, we may subdivide them into two groups—

A. Where both loculi are in front of the transversalis fascia.

B. Where the second or deep sac is behind the transversalis fascia.

The first group, A, admits of several examples—

(*a*) The simplest form met with is when in the sac of an ordinary acquired or congenital hernia there is a constriction at the site of the external ring, and the sac assumes an hour-glass form. With a congenital hernia a modification of this may arise where the constriction is in

the scrotum itself, due to a narrowing in the peritoneal sac at the junction of its funicular and vaginal portions, the indication of attempted closure between them.

(*b*) A form of sac, the outcome of imperfect descent of the processus vaginalis into the scrotum, where the peritoneal sac, after emerging from the external ring, spreads upwards and outwards over the anterior surface of the external oblique. If the testis descends it occupies this sac, but it may be retained in the abdomen; whatever the position of the testis may be, the hernia will occupy this superficial sac, and it may also extend a short distance down into the scrotum. If the testis is present in the sac it gives the abdominal variety of ectopia testis. Cases of this nature have been recorded by Scarpa, Kuster, and Hulke, and I myself reported two others in the 'Brit. Med. Journ.,' June 10th, 1899.

(*c*) In this form a diverticulum arises in the inguinal canal and extends upwards between the layers of the muscular wall; it represents Birkett's intra-parietal inguinal hernia. Goyrand, under the term "hernie inguino-interstitielle," describes an exactly similar development of congenital origin where the dilatation of the sac in the inguinal canal is associated with inguinal retention of the testis; the sac is placed anteriorly to the conjoined tendon between it and the external oblique.

To group B belong the following:

(*a*) Properitoneal hernia of Krönlein, with which this paper chiefly deals.

(*b*) Prevesical hernia, hernia inguinalis antevesicalis of Parise.

The essentials which determine a properitoneal hernia, which may be either inguinal or crural, are the presence of a second deep sac behind the transversalis fascia through which the more superficial one in the inguinal region makes its communication with the peritoneal cavity.

As to the origin of this hernia, Kronlein has laid particular stress upon its relationship with imperfect descent of the testis. In his statistics of twenty-three cases, twenty-

two occurred in men and one in a woman; of these, thirteen were on the right side. Of the whole, fifteen were definitely congenital, and nine of these, again, had defective descent of the testis.

Imperfect descent of the testis, which is very likely to be present, especially when the hernia is on the right side, is associated with errors in closure of the processus vaginalis. Whether the testis is normally descended, imperfectly so, or not at all, non-obliteration of the processus vaginalis, especially in the vicinity of the internal ring, is a very potent factor in the production of this form of hernia; by the attempted shutting off at the internal ring there is formed a small rigid opening, oval or rounded in shape.

It is a well-known fact that delay in closure of the processus vaginalis and imperfect descent of the testis are much more frequent on the right side for developmental reasons; statistics drawn from cases of hernia (only selecting those where want of proper closure of the processus vaginalis was definitely the case) prove how much more often they are on the right side, and Krönlein's statistics of properitoneal cases gave thirteen out of the twenty-three on the right side.

Between the posterior surface of the transversalis fascia and the parietal peritoneum at the site of the internal ring there is an appreciable portion of the processus vaginalis surrounded by loose subperitoneal tissue.

If this last and the contracted orifice between it and the peritoneal cavity contribute to the formation of this hernia, the question arises how do the bilocular sacs develop?

One view put forward is that the intra-abdominal (properitoneal) sac is the first to form from the distension of the intra-abdominal part of the processus vaginalis, free to do so in its loose bed of subperitoneal connective tissue. This distension, moreover, is facilitated by the resistance offered by the abdominal muscles to the dilatation of that part of the process in the inguinal canal. If this be the

case this resistance must be eventually overcome to allow of its dilatation later to form the second sac; a factor which would come into play here is a limit to the possible distension of this intra-abdominal sac. In favour of this statement is the view put forward by Macewen that in some cases of hydrocele *en bissac* the intra-abdominal sac does form first owing to the presence of adhesions in the upper part of the funicular process; next from some sudden strain these give way, and fluid goes down to distend the patent process below, either collecting in the scrotum if the tunica vaginalis is not shut off, or, if so, reaching to the scrotum and dilating the lower part of the funicular process.

Another view taken is that one originally put forward by Streubel. He maintained that there is a hernia passing down towards the scrotum first, and the properitoneal sac develops afterwards. What conduces to this formation is (1) the constricted opening at the inner ring hinders the return of the contents of the sac into the peritoneal cavity; (2) the reduction of these contents, especially if pushed back roughly by the patient or crowded back by a badly fitting truss, causes the peritoneum to be loosened about the inner ring and to be pushed backwards; the hernial contents then distend laterally the peritoneum in the sub-peritoneal tissue and thus form a properitoneal sac. The value of this small inner opening as a causative factor is shown by the large preponderance of the cases showing defective closure of the processus vaginalis. In an acquired hernia, where the sac is formed by a pouching of the parietal peritoneum opposite the inner ring, there is always a somewhat definite proportion between the size of the opening and the extent of the sac; hindrance to the return of the sac contents is not nearly so likely from this cause. In any hernia of the congenital type there is marked disproportion between the size of the opening and the rest of the sac. The opening is rigid and sharp, due to a continued attempt from earliest days to effect a closure between the general peritoneal cavity and the sac.

This is the condition which is most likely to cause acute strangulation, and in these cases it is recognised how very difficult it is to affect reduction.

Tessier's opinion was that there was a reduction *en masse* of sac and contents behind the transversalis fascia and secondary pouching again into the inguinal canal; this origin is also maintined by Gosselin.

Linhart and Bär's views.—They drew attention to diverticula described by Rokitansky in the neighbourhood of the inguinal and crural openings. When these have reached some size they tend to pouch through the canals and form a second sac. This is the explanation that Bär gives for his "hernie en bissac," and Moynihan in his "Arris and Gale" lectures rather inclined to the view that these diverticula did play some part in the development of this hernia.

Several other rather far-fetched opinions have been offered on this matter, but, to sum up, nothing more definite can be said than that in the majority there appears to have been defective closure of the processus vaginalis, and in a large proportion of these there is imperfect descent of the testis.

In this patient the testis had descended into the scrotum, but we may assume that the sac was a congenital one, as it was surrounded by the elements of the cord, a common feature in these cases and most unusual in an acquired hernia.

The diagnosis in this case appeared to be an acute obstruction of not more than forty-eight hours' duration, without any very evident explanation. It is true that he was the subject of hernia which had never given him any bother in its reduction, and that there was some indefinite increased resistance under chloroform behind the inner part of the os pubis, but his canal and rings were not abnormally empty, such as occurs in reduction *en masse* of the sac and contents. No doubt, if his condition had not been so urgent and there had been more time to fully consider his case, we might have suspected the possibility

of a properitoneal hernia. Pressure on the swelling did not, however, cause any hernial tumour in the canal. There was no puffiness of the cord about the external ring on which Richter has commented, and, as before stated, no tumour could be felt *per rectum*.

In a properitoneal hernia the site of strangulation may be at the inner opening into the peritoneal cavity, or at the junction of the two sacs. In this case, from the small size of the opening and the marks on the bowel from the sharp constriction of the ring, with the general condition of the bowel, there could be no doubt where the strangulation had occurred. Certainly a small amount of the lumen of the bowel which bulged into the common opening between the sacs, suggesting a Richter's hernia, was a little darker than the rest, but this I think was accidental; before his acute symptoms there had been no diarrhœa, which is likely to occur. Although his obstruction was acute, the thickened and dilated bowel above the site of nipping suggested that there had been previously interference with its proper movements, in spite of no direct history supporting this.

Examination of the specimen shows the anatomical features of such a hernia very distinctly. The sac is an extensive one, and its close approximation to the bladder will be appreciated. On reference to the case of prevesical hernia described in the 'Transactions' by Mr. Makins, and to those recorded by Parise, it will be seen that the differences are very great.

The only other point of note is the presence of a small diverticulum to the inner side of the sac agreeing with those described by Rokitansky, and upon which Bär has laid stress as a factor in the causation of this form of hernia.

DISCUSSION.

Mr. W. McAdam Eccles considered that properitoneal hernia must be clearly distinguished from interstitial hernia. There was a preponderance of the former in the male subject and of the latter in the female, which could not, therefore, be always related to imperfect descent of the testis. Most, if not all, cases of properitoneal hernia showed a defect in the descent of the testicles, and he asked if the testes in Mr. Robinson's case were of equal size and development. An imperfectly descended testis blocking the pouch of the peritoneum in the canal and the descent of the bowel on to the top of it tended to form the bilocular or properitoneal sac. The testis usually descended later on, after the development of the hernia. All such cases, he thought, should be explored, for operation in cases of imperfect descent of the testis with protrusion would prevent the formation of a second sac and its consequent dangers.

Mr. Betham Robinson, in reply, said that Krönlein did not record a case of properitoneal hernia in the female. A crural form of properitoneal hernia did, however, occur in females. The testes in his case were normal. There was a distinct differentiation between the properitoneal and interstitial herniæ, as the latter was in front of the transversalis fascia.

H. Betham Robinson: Properitoneal Hernia. *Plate I.*

A—Opening into inguinal sac (cut away).
B—Pampiniform plexus of veins.
C—Vas deferens.
D—External oblique muscle.
E—Internal oblique muscle.
F—Transversalis muscle.
G—External iliac vessels.
H—Peritoneum and subperitoneal connective tissue.

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H. Betham Robinson: Properitoneal Hernia. Plate II.

A—Properitoneal sac.
B—Its internal opening (normal internal ring).
C—Bladder.
D—Lower part of sigmoid.
E—Pelvic peritoneum.
F—Small peritoneal fossa.
G—Rectus muscle.
H—Oblique and transversalis muscles.
I—Peritoneum lining abdominal wall.

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DESCRIPTION

OF A

SIMPLE AND EFFICIENT METHOD

OF

PERFORMING ARTIFICIAL RESPIRATION IN THE HUMAN SUBJECT

ESPECIALLY IN CASES OF DROWNING

TO WHICH IS APPENDED INSTRUCTIONS FOR THE TREATMENT OF THE APPARENTLY DROWNED

BY

E. A. SCHÄFER, F.R.S.

Received 25th November, 1903—Read 8th December, 1903.

THE mechanical methods of performing artificial respiration in the human subject which have been most in use up to the present time are—

1. The Marshall Hall method, which consists in placing the subject in the prone position and rolling the body alternately into the lateral and prone position, making pressure upon the back when in the latter position.

2. The Silvester method, in which the capacity of the chest is increased by raising the arms above the head and thus dragging upon and elevating the ribs, the chest being emptied by placing the arms against the sides of

the chest and exerting lateral pressure on the thorax. The subject is throughout in the supine position.

3. The Howard method, which consists in emptying the thorax by forcibly compressing the lower part of the chest: on relaxing the pressure the chest again fills with air. The subject is throughout in the supine position.

It has been shown[1] that all these methods can be made to effect a sufficient intake of air in the human subject, but each one of them is attended by certain disadvantages, which become accentuated when the subject is in an asphyxiated condition, and especially when the asphyxia is due to drowning. For under these circumstances all the muscles are in a limp, relaxed condition: if the head is thrown back, as when the subject is supine, there is a tendency for the tongue to fall back into and to block the pharynx: there may be water in the air-passages, and an abundance of mucus is usually secreted, which, becoming churned up into a froth with the air and water, tends to block the bronchial tubes. There is also an enormous congestion and swelling of the liver, combined with and caused by great distension of the heart, especially of the right cavities. This last-named circumstance, viz. the congestion of the liver, renders the application of the Howard method extremely dangerous in cases of drowning, since forcible pressure upon the lower chest under these conditions is apt to produce rupture of the liver, an accident which occurred on several occasions in the dogs experimented upon by Dr. Herring and myself in our investigations into this subject for the Committee of the Royal Medical and Chirurgical Society.

The supine condition is strongly contra-indicated (1) on account of the tendency which there is in this position for the tongue to fall back, and (2) because this position does not facilitate but rather hinders the escape of the water, mucus, and froth from the air-passages, throat, and

[1] Report of Committee on Suspended Animation, 1903. The amount of exchange per unit of time was, however, not determined.

mouth. The Marshall Hall method has not these disadvantages, but it involves a considerable amount of physical labour, and the rolling of a heavy inert body over upon hard ground or upon the planks of a boat may easily produce bruising and superficial injuries which it should be our endeavour to avoid. The Silvester method, besides the objection that it involves the supine position, an objection which is peculiarly applicable to drowning cases, also demands a very large amount of physical exertion; and the dragging upon the humero-thoracic muscles tends to strain and otherwise to injure them. From the physiological point of view there is a fundamental difference between the Silvester method on the one hand, and the Howard method on the other, since the Silvester method is active in producing inspiration while expiration is passive, whilst in the Howard and other pressure methods, expiration is produced actively and inspiration is passive. Since the former appears more exactly to imitate the normal conditions of respiration, it might at first sight be supposed on that account to be preferable, but there is another element to take into consideration, viz. the part which is played by the nervous centre of respiration. For it has been shown (by Hering and Breuer, and by Head) that a main factor in exciting inspiration is the emptying and concomitant collapse of the lungs, so that if they are mechanically caused to collapse the inspiratory centre is stimulated through fibres of the vagus nerves distributed to the lungs, and, when the centre is acting, a normal inspiration is the result of such stimulation. On the other hand, mechanical inflation of the lungs has a tendency to inhibit inspiration and to depress the activity of the respiratory centre. During complete asphyxia the activity of that centre is in abeyance, but, as the subject begins to pass out of the asphyxial condition, it tends to resume its functions, and it is therefore clearly preferable to employ a method of artificial respiration which will stimulate the centre to activity rather than one which will depress its activity. Hence any pressure method is, on

physiological grounds, to be preferred to a traction method —apart altogether from the greater simplicity of manipulation. Further, for the reasons above given, the prone position is to be preferred to the supine, especially in cases of drowning.

The method about to be described presents none of the disadvantages which have been enumerated in considering the older methods. It is safe, efficient, and involves a minimum amount of labour on the part of the operator. It consists in laying the subject in the prone posture, preferably on the ground, with a thick folded garment underneath the chest and epigastrium. The operator puts himself in a position athwart or at the side of the subject, facing his head and kneeling upon one or both knees, and places his hands on each side over the lower part of the back (lowest ribs). He then slowly throws the weight of his body forward to bear upon his own arms, and thus presses upon the thorax of the subject and forces air out of the lungs. This being effected, he gradually relaxes the pressure by bringing his own body up again to a more erect position, but without moving the hands: as he does this, air is drawn, by the removal of pressure from the chest walls and by their elastic reaction, into the lungs. This process is repeated quite regularly and without manifest intervals between the movements not less often than twelve times a minute: it may be done somewhat more rapidly, but fifteen times a minute would, in any case, be sufficient. By this means it is easily possible in an average man to effect an exchange of fully 6500 cubic centimetres per minute[1]— an amount which is more than enough to maintain complete aëration of the blood.

The advantages of this method may be thus enumerated:

[1] The data upon which this statement is made are given in a paper by the author presented to the Royal Society of Edinburgh, and published in the 'Proceedings' for 1903. The other methods all yielded far smaller results.

(1) The ease with which the physical operations necessary to carry on artificial respiration may be performed; hardly any muscular exertion is required.

(2) The efficiency of the gaseous exchange produced by it between the outside air and the air in the lungs.

(3) The extreme simplicity of the procedure; no complex manipulations are required.

(4) The impossibility of the air-passages being blocked by the falling back of the tongue into the pharynx.

(5) In cases of drowning the readiness with which water and mucus are expelled from the air-passages through the mouth and nostrils.

(6) It involves no risk of injury to the congested liver or to any other organ.

Instructions for the Treatment of the Apparently Drowned.

Immediately on removal from the water, place the patient face downwards on the ground with a folded coat under the lower part of the chest. Not a moment must be lost in removing clothing. *If respiration has ceased, artificial respiration is to be commenced at once: every instant of delay is serious.*

To effect artificial respiration put yourself athwart or on one side of the patient's body in a kneeling posture and facing his head (see figure). Place your hands flat over the lower part of the back (on the lowest ribs), one on each side, and gradually throw the weight of your body forward on to them so as to produce firm pressure—which must not be violent—upon the patient's chest. By this means the air (and water, if there is any) is driven out of the patient's lungs. Immediately thereafter raise your body slowly so as to remove the pressure, but leaving your hands in position. Repeat this forward and backward movement (pressure and relaxation of pressure) every four or five seconds. In other words, sway your body slowly forwards and backwards upon your arms

twelve to fifteen times a minute, without any marked pause between the movements. This course must be pursued for at least half an hour, or until the natural respirations are resumed. If they are resumed and, as sometimes happens, again tend to fail, the process of artificial respiration must be again resorted to as before.

Whilst one person is carrying out artificial respiration in this way, others may, if there be opportunity, busy

Figure showing the position to be adopted for effecting artificial respiration in cases of drowning.

themselves with applying hot flannels to the body and limbs, and hot bottles to the feet; but no attempt should be made to remove the wet clothing or to give any restoratives by the mouth until natural breathing has recommenced.

Hypodermic injections of atropine sulphate ($\frac{1}{100}$th to $\frac{1}{50}$th grain) and of supra-renal extract (either as adrenalin chloride or in any other form) may be used to assist recovery.

DISCUSSION.

The PRESIDENT, in introducing Professor Schäfer's communication, said that it contained the author's conclusions on the best method of carrying on artificial respiration in the apparently drowned. It was the outcome of a paper communicated to the Society a short time ago (1903) by Professor Schäfer, on behalf of the Committee on Suspended Animation appointed by the Society, and represented Professor Schäfer's own individual views.

Dr. BOWLES said that as he had so recently and so fully discussed the Report of the 1902 Committee, it would be unnecessary to do more than consider the method of resuscitation then proposed by Professor Schäfer as safe, simple, and sufficient. It was true that it was simple, and inasmuch as it was exactly and no more than the first movement in Dr. Bowles' own method, a copy of which he had sent to Professor Schäfer some time prior to the presentation of the Report, he (Dr. Bowles) agreed in principle with Professor Schäfer's method of introducing air into healthy lungs with diaphragm, respiratory muscles, ribs, and cartilages in their natural elastic condition, and air cells and lung tissue resilient and free from fluid or other obstructions; but in drowning Dr. Schäfer had again confirmed what Dr. Bowles had often found and reported during the last forty years in drowned human beings, that all the muscles were in a limp and relaxed condition, and that there was always a danger of the tongue falling back and adding to the asphyxia, and for fluids and mucus to be churned into froth, and so still further adding to the obstruction in the air-passages; the lungs too were sodden, hydræmic, and inelastic, and the chest walls much less elastic than in the healthy man.

It could not be expected, under the conditions existing in the drowned, that pressure on the back alone with the patient in the prone position could effect sufficient gaseous exchange between the outside air and the air in the lungs, as claimed by Professor Schäfer. Dr. Bowles had indeed as long ago as 1871 introduced two other movements, which he had found from experience of great use in obtaining real efficiency.

1st. The rolling the patient from the prone position on to the right side to increase chest expansion, and so introduce more air and relieve the heart and circulation from pressure, and at the same time allow the liver to rest, as it were, on the ground.

2nd. After a time—ten minutes or more,—when most of the froth and fluids had been removed from the surcharged lung, the patient's upper arm might be carried above the head, but with the patient on his right side, not on his back, as recommended by Dr. Sylvester.

The reasons for those movements were derived from his own experience, and that of other members of the profession, not only in drowning, but in comatose conditions generally, the mucous stertor of apoplexy, hæmoptysis, drunken stupor with vomited matter in the pharynx, bronchitis, and other maladies.

In his late speech on the Report, and especially in former papers, he had referred more in detail to such conditions, and he had still more recently dealt with it in his pamphlet on 'A Method for the Treatment of the Apparently Drowned.' It was clear that the Committee's Reports of 1862 and of 1902 were in practical agreement, and that they fully confirmed the soundness of the principles of the Marshall Hall method. Later experiences had, however, enabled Dr. Bowles to correct a few details in the application of those principles, so as to ensure complete efficiency in the method of treatment then submitted for the use of the public. The propriety of the application of warmth, of subcutaneous or rectal injections, of stimulants, or other medical means at particular moments could only be properly arrived at under medical supervision.

Mr. WARRINGTON HAWARD thought the unprejudiced listener would see that both the methods alluded to in the discussion had advantages and disadvantages. But methods applicable to asphyxiated persons were not applicable to drowned persons. In the drowned the first necessity was to get rid of the fluid and froth from the lungs; hence the prone position is advisable in the early stages of the treatment. But something more than the measures recommended by Prof. Schäfer was required, and this, as Dr. Bowles had pointed out, was furnished by the rolling movement with a modification of the Silvester method by raising the free arm. It was also, no doubt, important to keep one lung clear by always keeping the patient on the same side. Thus it seemed to him that for the drowned the method of Dr. Bowles was superior to all the other methods—it combined their advantages, avoided their disadvantages, and added what was necessary to make them efficient. He suggested that the Society might now publish some definite pronouncement upon this matter.

Dr. F. W. HEWITT endorsed the remarks of Mr. Warrington Haward. Dr. Bowles' method seemed the most likely to meet the generality of cases of asphyxia from drowning. He considered the prone method inadmissible because, at all events in the case of the deep unconsciousness produced by anæsthetics, the trunk weight was liable to interfere with or prevent that

elastic recoil of the parietes upon which lung expansion depended. He referred to a case of embarrassment of breathing in an anæsthetised infant from mucus in the air-passages, to whose chest he applied intermittent pressure, and it seemed that with each pressure less air was drawn into the chest, until at the fifth compression none entered, respiration coming to a standstill in the expiratory phase. Air was forced out, but the mucus seemed to act like a valve and prevent its entry. Fortunately respiration spontaneously recommenced after about two minutes' complete cessation, artificial respiration having failed to effect the entry of air. It was perhaps more important to provide for inspiration than for expiration, and the value of lung inflation must not be forgotten. He thought bleeding to relieve the right heart was probably a useful help to recovery.

Dr. F. P. WIGHTWICK also endorsed what Mr. Haward had said, especially as to the need for the Society formulating some authoritative rules. The Silvester method, although it was not certain that it was the best, was recommended everywhere, and advertised throughout the country. It was important that a definite instruction on the matter should be given by the Society.

Dr. M. S. PEMBREY, speaking from the physiological side, thought that the experiments by Hering and Breuer, quoted by Professor Schäfer, were not to the point, as the animals were under anæsthetics and were breathing, the nervous centres not being in abeyance as in drowning. Besides, impulses by the vagus were not essential to respiration; breathing went on after they were divided: absence of oxygen and excess of CO_2 were the important factors in the act. In regard to expiration or inspiration, it seemed to him that Dr. Bowles' method was the better, and one of the most important factors was to start the circulation so as to get oxygen to the medulla; this was helped by establishing negative pressure by the inspiratory movement, which was a part of both Dr. Bowles' and Dr. Silvester's methods. Similarly venesection was useful. This method of artificial respiration was absolutely useless in the case of a new-born infant, as the lungs were solid. Moreover, if, during even the first few days of life, the chest was opened, the lungs did not collapse, because they were not on the stretch as they were later owing to the chest growing more rapidly than the lungs. The old method practised by farmers in the lower animals of directly blowing air into the lungs was much to be preferred. The question of the rigidity of the thorax was also important, as in old persons no recoil was obtainable; the respiration in them was mainly abdominal, hence a combination of the methods was desirable. The importance of warmth was great, because it antagonised the depression of the nerve centres. As to fluid in the lungs, it was so rapidly absorbed that its presence was of

secondary importance. The Silvester method, he thought, did not meet all the requirements, but Dr. Bowles' combined method seemed adequate.

Dr. G. NEWTON PITT thought it would be desirable for any cases of rupture of the liver by the Howard method to be put on record; they were probably very few in the human subject.

Dr. HENRY R. SILVESTER said that the method advocated and described by the author as "simple and efficient" had the merit of being extremely ancient, having been practised in principle from time immemorial down to the middle of the eighteenth century, and might be called the simple compression method. Simple compression had been performed with varying details. Sometimes the patient was treated on the ground, but when possible the body was laid on a table with the head hanging over the edge, and pressure made on the back of the thorax by the hands of the operator. Before the importance of the function of respiration was fully appreciated it was probable that the object sought was the removal of the water from the body of the drowned person, which was believed to be the cause of danger, and there was no doubt that water when swallowed could be, by this simple means, removed from the stomach, although not from the lungs, which, as is well known, seldom or never contain any large amount. Water in the stomach is usually vomited on recovery. During **the eighteenth century the simple compression plan passed into the rolling method.**

Dr. Silvester then quoted several of the earliest recorded cases in which the rolling method was used, with full details of the process, but this treatment was soon found to be "coarse, inefficient, and dangerous," and had to be discontinued. In the year 1774 the public were cautioned by the Royal Humane Society that "experience proves that this treatment is injurious, and often destroys the small remains of life;" and by the year 1862 all treatment by direct mechanical compression was rejected, and the directions issued by this society might be summed up in two words, "Apply warmth."

With regard to the means of restoring respiration in the apparently dead by drowning, Dr. Silvester stated that the instructions given by Professor Schäfer would be generally admitted to be faulty in principle, for it was sought by these instructions to make expiration precede inspiration, whereas in natural breathing expiration was always second in order, and not the primary act. In stillborn infants, whose lungs had never been inflated, forced expiration at first was, of course, impossible. A similar objection applied to the Marshall Hall rolling method. In most cases of asphyxia the chest was in a state of expiration, and therefore pressure on the thorax as directed by these instructions would not only aggravate this

existing evil, but would at the same time increase the passive congestion of the thoracic viscera.

Next with regard to the means to be employed to effect forced inspiration in the apparently drowned. After quoting the instructions given by Professor Schäfer, he said that in the unconscious person with the functions of the nervous system in complete abeyance, and the thorax in a condition of expiration, the expansion of the chest walls required for inspiration was dependent alone on the elasticity of the costal tissues, and consequently could take place only feebly and inefficiently unless receiving some active mechanical aid. But when the patient was lying prone, with the weight of his body resting on the most mobile part of his chest, and the diaphragm pressed up by the abdominal viscera against the lungs, and the vital capacity of the chest thereby diminished, he was placed under the most serious embarrassment so far as the entrance of air into his lungs was concerned. In order to obviate this evident disability, the plan of rolling very naturally superseded that of simple compression in the prone position, for, by rolling the body backwards, the natural resiliency of the ribs was allowed fuller play, though on one side of the chest only, and, in consequence, a limited amount of air could be drawn into the lungs. Any advantage possessed by the rolling method over simple compression was, however, neutralised by the danger of fracturing the cervical vertebræ, the fatigue of turning the almost lifeless body alternately on the chest and on the back fifteen times in a minute for some hours, and the employment of only one side of the chest at a time; also the congested condition of the heart and thoracic viscera rendered the pressure in the prone position dangerous in the treatment of cases of drowning; while the free elevation of the ribs on both sides of the chest, which is possible in the supine position of the body, and offered facilities for removing this state of congestion, was not taken advantage of.

The next point considered was what was the amount of air respired. It was ascertained by means of experiment that the amount of air inspired by this method was exceedingly small, and compared most unfavourably with the amount obtained in the Silvester method. The greater the amount of air inspired with each effort of the operator, the shorter would be the time required for recovery, and the better would be the prospect of resuscitation, for the greater would be the number of air-cells exposed to the revivifying influence of the oxygen admitted.

With regard to the amount of pressure likely to be exerted in following out the instructions given by Prof. Schäfer, when carried out by a seafaring population, he said that the pressure on the patient's chest would not be less than from thirty to forty

pounds. The weight exerted by the operator on the chest wall would probably be dangerous in the case of infants and the aged. He pointed out that another great objection to this form of treatment was that it could not be carried out in a hot bath; a similar objection applied to the Marshall Hall rolling method, and this would render impossible the universal adoption of either of these systems. The Silvester method was the only one which could be employed in a bath, and the hot bath was deemed by the Royal Humane Society of the greatest value in the treatment of the apparently drowned, and in all cases of absence of natural respiration.

The posture of the operator, "athwart the patient," as illustrated in the professor's paper, in respect of female patients was, moreover, undesirable.

The alleged injury to the humero-thoracic muscles was not substantiated in the actual use of the Silvester method, the elasticity of the thoracic parietes obviating such a result; and he stated that the plan he adopted when the operations had to be prolonged, or the subject unwieldy, was to place the hands in the axillæ of the patient, and draw up his shoulders towards his head for two seconds for inspiration, and to replace the arms by his side and press them for two seconds against his chest for expiration, the feet being secured. This entirely avoided fatigue.

The objections to Prof. Schäfer's suggested treatment were—first, that expiration was made to precede inspiration when the condition of the chest was already in a state of expiration; secondly, that inspiration was opposed by the weight of the patient resting on the front of his chest; thirdly, that pressure on the thorax was injurious when the heart and thoracic viscera were already in a state of congestion; fourthly, that pressure on the back in the prone position was objectionable, as the abdominal viscera by compressing the diaphragm limited the vital capacity of the chest, and for obvious reasons this form of treatment was often inappropriate in the case of female patients; fifthly, that the contents of the stomach were liable to pass into the windpipe: sixthly, that a dangerous amount of pressure might be exerted on the costal parietes; seventhly, that the amount of air inspired was much smaller than by other methods; eighthly, that the employment of the hot bath was impossible.

The PRESIDENT (in closing the discussion) said, in reply to Mr. Howard and Dr. Wightwick, that clearly the first duty of the Society was to have this subject investigated by a competent committee. This had now been done, and the results had been communicated to the Society. Now that Dr. Bowles and Dr. Silvester, whom he might call the champions of the Marshall Hall and the Silvester methods, admitted that there were not only good

features in both plans, but that each adopted in practice some part of the other's procedure. Again, as Professor Schäfer's method was the prone position of the Marshall Hall, with intermittent pressure in the place of rolling, it seemed as if the Society had reached the stage when they would be able to formulate a method for the treatment of the apparently drowned, and this was certainly very desirable.

APPENDIX.

Professor SCHÄFER, who was unable to be present either at the reading of his paper or at the subsequent discussion, appends the following remarks on the discussion:

A majority of the speakers have expressed opinions in favour of the Marshall Hall method, with the additions recommended by Dr. Bowles; Dr. Silvester, as was perhaps natural, continues to hold the view that the only suitable means for effecting artificial respiration is that introduced by him and known by his name.

So far as I am aware, no one of those gentlemen who have expressed their opinion on this matter has made any measurements or comparative experiments as to the relative efficiency of the several methods which have been advocated, and especially as to their adequacy to maintain the air exchange of the living subject. It is not sufficient, in order to determine this adequacy, to measure the amount of air which can be exchanged in a single movement of artificial respiration; but it is essential to be able by any given method to obtain an air exchange *per minute* equal (or nearly so) to that yielded by the ordinary respiration of the individual who is the subject of the experiment; and not only so, but also to be able to maintain this air-exchange for half an hour or an hour with little inconvenience to the subject and without fatigue on the part of the operator. Dr. Silvester and Dr. Bowles both claim that their methods are more efficient than any other, and Dr. Silvester goes so far as to deny, on purely *a priori* grounds, that the prone-pressure method advocated in the paper under discussion *can* be efficient. These are, however, merely pious opinions, and require only the test of experiment to demonstrate their fallaciousness. I have myself again and again made the attempt by both methods (Silvester and Bowles) to maintain respiration in the living subject, and have entirely failed. In point of fact, after the space of about a minute the subject of the experiment can no longer remain passive; he is compelled to breathe. And this is easily understood, for we find that by neither method is an

amount of air exchange per minute effected nearly as great as the air exchange of natural respiration. With the pressure methods, and especially with the prone-pressure method here described, it is far otherwise. In this method the amount of air exchange per minute can be experimentally demonstrated to be *greater than* the normal air exchange of the individual, so that by it respiration can be maintained artificially for an indefinite time without the subject having the least desire to breathe naturally: I have myself so maintained it in one individual during a full hour.

The experimental evidence (which I have given at length in the 'Proceedings of the Royal Society of Edinburgh,' and which is also stated briefly in an appendix to the Report of the Committee on Suspended Animation) leaves room for no uncertainty as to the relative efficiency of the several methods under discussion. Thus in one subject, a young man of twenty-three, whose natural respiration at the rate of thirteen per minute produced an air exchange per minute of 5850 c.c., the Silvester method gave only 2280 c.c.; the Marshall Hall method 3300 c.c.; the Howard method 4020 c.c.; and the prone-pressure method 6760 c.c., all being worked at the same rate as the natural respiration. The addition suggested by Dr. Bowles to the Marshall Hall method of raising one arm over the head has in my hands only rendered it still more difficult to obtain a sufficient amount of air exchange *per minute*, on account of the extra time occupied by this additional complication. It is therefore very evident to me that Mr. Warrington Haward and Dr. Hewitt have not had any personal experience of this method, which they think superior to others. Let them try and keep a man going by its means without any aid from his own muscular mechanisms, and they will soon be undeceived as to its adequacy.

With regard to the criticisms of Dr. Pembrey, in so far as they have not been dealt with in my remarks on those of the preceding speakers it will be found that they have been already anticipated and discussed in the paper itself: this is the case with that relating to the nervous mechanism of respiration during asphyxia. His remark that the prone-pressure method is not applicable to the new-born child, a remark repeated later by Dr. Silvester, is an obvious truism, for the only mechanical methods applicable in that case are inflation and Schultze's swinging method. As to old people, the prone-pressure method is probably as applicable as any other, but in them lack of mobility of the chest walls must operate against all methods alike. In so far, however, as it produces pressure upon the abdominal contents, the prone-pressure method is independent of this lack of mobility, which cannot be affirmed of any of the other methods advocated.

The objections Dr. Silvester has raised hardly require special comment. Many of them are based on an incorrect conception of the mechanical conditions of the chest wall, as the simplest experiment is sufficient to show; and, for the rest, I have either answered them already in criticising the remarks of previous speakers, or the answer is too obvious for it to be necessary for me to prolong these remarks unduly. The special advantages of the prone-pressure method as against other methods hitherto in use are summarised in the paper (p. 613), and no single one of the statements there made has been seriously traversed in the above discussion.

CASES EXHIBITED AT MEETINGS.

A Case of Primary Chancre of the Tongue.

Shown by R. CLEMENT LUCAS, B.S., F.R.C.S. (Senior Surgeon to, and Lecturer on Surgery at, Guy's Hospital; Consulting Surgeon to the Evelina Hospital for Children) on October 27th, 1903.

H. T—, aged 35, a married man, who had a family of five healthy children, was admitted into Lazarus Ward, Guy's Hospital, on October 20th, 1903, suffering from a sore beneath his tongue. He was a strongly built, healthy man, of very sound family history, and a farrier by trade. About five weeks before he first noticed two little white spots beneath his tongue. These grew larger and formed a sore, for which he consulted a doctor and took medicine, but without benefit. The sore spread forwards, and became painful and tender during mastication, and for a fortnight he has noticed some swelling beneath the left side of his jaw. He has suffered from headache, and the sore when touched causes a shooting pain along the nerves, which is almost unbearable for a few seconds.

He is unable to account for the ulcer, "except that at his shop the men are accustomed to smoke the first pipe they see lying about."

Beneath the tongue, extending on either side of the frænum, is a shallow ulcer, almost perfectly symmetrical. The ulcer is about the size of a shilling, and extends forwards nearly to the tip of the tongue. The edges are slightly undermined, and its base indurated. It has a grey surface, and the surrounding parts are red and inflamed. It emits a foul odour, and is intensely painful if touched.

Beneath the jaw on the left side the glands are swollen and somewhat matted together; the swelling extends from the

symphysis almost to the angle of the jaw. They are not in the least tender, but hard to the touch, and adherent to the deep parts, but not to the skin.

On the flexor surfaces of his arms, on his chest and abdomen, there is an eruption of dusky brown papules. A few are also to be seen on his forehead. The surfaces of some of the papules are somewhat rough from thickened cuticle, but this scarcely amounts to a scale. The eruption is clearly a papular syphilide or syphilitic lichen. His generative organs were examined, and found to be free from any venereal affection.

He was treated with a mixture containing perchloride of mercury and iodide of potassium, and already improvement has taken place in the appearance of the chancre, its edges having become reduced. The glands also are less in size than when first seen; but no diminution in the rash has at present taken place.

Remarks.—By the kind permission of the President this patient is shown here as an exceptional case, presenting a chancre in a very rare situation. In the whole course of my experience as a hospital surgeon, now extending over a period of thirty years, this is only the second case that I have observed of a chancre on the tongue.

The other case occurred in a highly respectable clerk in a city office, whom I still frequently see. He was a man between fifty and sixty years of age, and he asked my advice as to a sore situated on the right upper edge of his tongue near the tip. I noticed that it was exactly opposite to a jagged artificial tooth-plate, from which a tooth had been broken out, leaving a sharp metal edge. I thought this enough to account for the sore, and told him to remove the tooth-plate and use a simple chlorate of potash lotion. When I saw him a fortnight later I was surprised to see the sore more distinct and with a well-defined rim. Some enlarged glands also attracted my attention underneath the jaw. I then examined his arms and chest, and found a brownish macular eruption just appearing. He was treated with small doses of perchloride of mercury and passed through a modified secondary stage under my observation. This occurred about twelve years ago, and he remains in good health. I presumed that the artificial tooth-plate had abraded the surface of the tongue, which had then been brought into contact with some infected drinking-vessel or pipe. I do not think that in either of these cases there was any likelihood of the chancre having been acquired in such a way as Continental surgeons describe as probable.—(*Reported by A. W. Eyles.*)

Case of Malignant Disease of the Rectum in which great improvement had occurred after Colotomy.

Shown by HOLLAND J. COTTON, M.D., C.M.

The patient, a man aged 44 years, who had always had a sallow complexion, and never had syphilis or gonorrhœa, first began to pass blood and mucus four years ago. Two years ago he was examined, and an ulcerative stricture high up in the rectum was found, and was diagnosed by a surgeon as carcinoma, and colotomy was advised to relieve pain The patient declined colotomy, and attended his work daily with the help of cocaine and morphine suppositories. A year later Mr. W. Arbuthnot Lane suggested incising the stricture as the ulceration had diminished, but shortly afterwards high fever, diarrhœa, and tendency to delirium set in, simulating typhoid fever. No implication of the neighbouring glands could be detected. This grave condition lasted six weeks, and there was evident burrowing of pus and fæces in the tissues, which finally came to a head in a large ischio-rectal abscess, which Mr. Lane incised. On March 19th, 1903, the patient was admitted to Guy's Hospital in a desperate condition, and Mr. Lane performed colotomy in the left iliac region, although the microscopical report of a piece of ulcerated rectum was "columnar-celled carcinoma." The operation was performed in four stages. On April 1st an incision was made and the colon was stitched to the skin, but not divided. To allay the suffering from the consequent obstruction and distension morphine was given till the fifth day, when the bowel was divided and Paul's tube was inserted. On the eighth day the protruding loop of colon was cut through, and the lower end was clamped and Paul's tube removed, and on the eleventh day the clamp was removed. The patient made a steady recovery, and left the hospital in six weeks, and was very soon able to resume his work. He had now regained his usual weight of fourteen stones, though at the time of the actual illness he weighed about twelve stones. There was still occasional discharge of mucus and blood from the anus, but he had lost the intolerable pain, and found no discomfort from the artificial anus, for which no plug or pad was worn.

Dr. Cotton submitted the following questions:

(1) What was the man's complaint?

(2) Was not the fact that he recovered from the blood-poisoning, of burrowing pus and fæces sufficiently to allow of colotomy, and had now enjoyed ten months' good health, regaining his natural weight of fourteen stones, inconsistent with the theory of cancer of three years' standing?

(3) Did not true cancer live upon its host and produce emaciation and a cachexia, in which such a serious operation would have been fatal?

(4) Was the microscope at fault, or rather, was the microscopist at fault? for columnar cells were the natural cells of the epithelium of the intestine.

(5) Was it wise to apply the term "cancer" to diseases of low malignancy which might last for years?

The PRESIDENT said that he had seen a long period of quiescence after colotomy in cases of malignant disease, no doubt due to the functional abeyance in which the parts affected were thus maintained.

Mr. A. W. MAYO ROBSON said that if inflammation was added to carcinoma of the rectum there was a great accession of symptoms, and if this inflammatory condition could be relieved a very marked improvement might take place. He referred to a case where colotomy had given relief for five years, and to others where relief had been given for long periods. The lesson to be learnt from these cases was that a radical operation should be performed early if the growth was limited, and if it had advanced too far for this a colotomy should be performed. He referred to several cases which appeared to be undoubted cases of carcinoma, and in which, after a colotomy had been performed the growth entirely disappeared. He did not mean that these were cases of cancer cured by colotomy, but that they were cases simulating cancer very closely.

Mr. H. J. PATERSON referred to the value of a microscopical examination, and said he had seen a patient who, three and a half years after colotomy for carcinoma, was in good health.

Mr. F. C. WALLIS said he had examined Dr. Cotton's patient, and he had no doubt that he had carcinoma of the rectum. From his own experience he could state that tubercle might sometimes simulate a carcinomatous mass.

Mr. D. J. ARMOUR referred to a case of a long quiescent period after colotomy.

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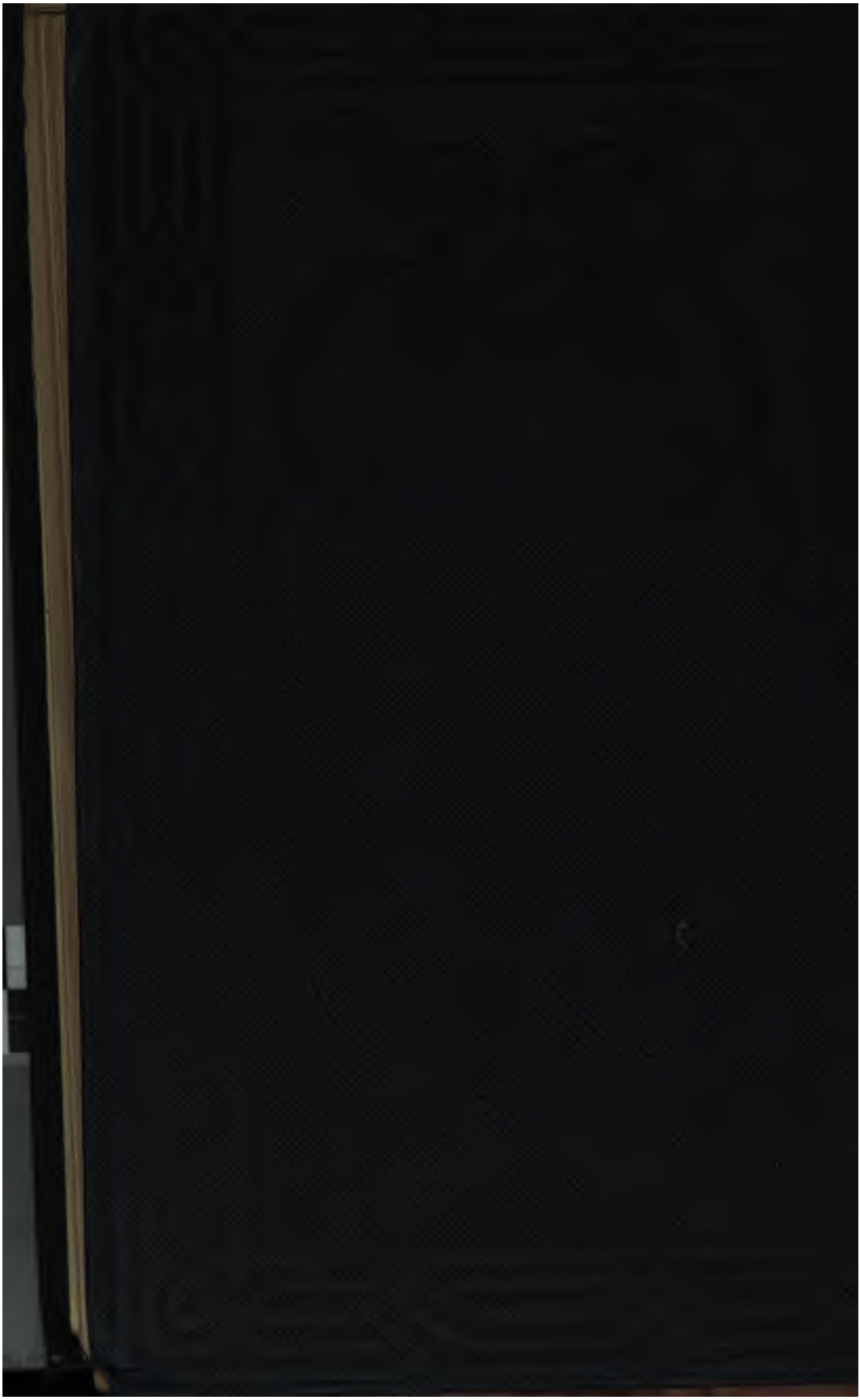
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